INSTRUCTION MANUAL

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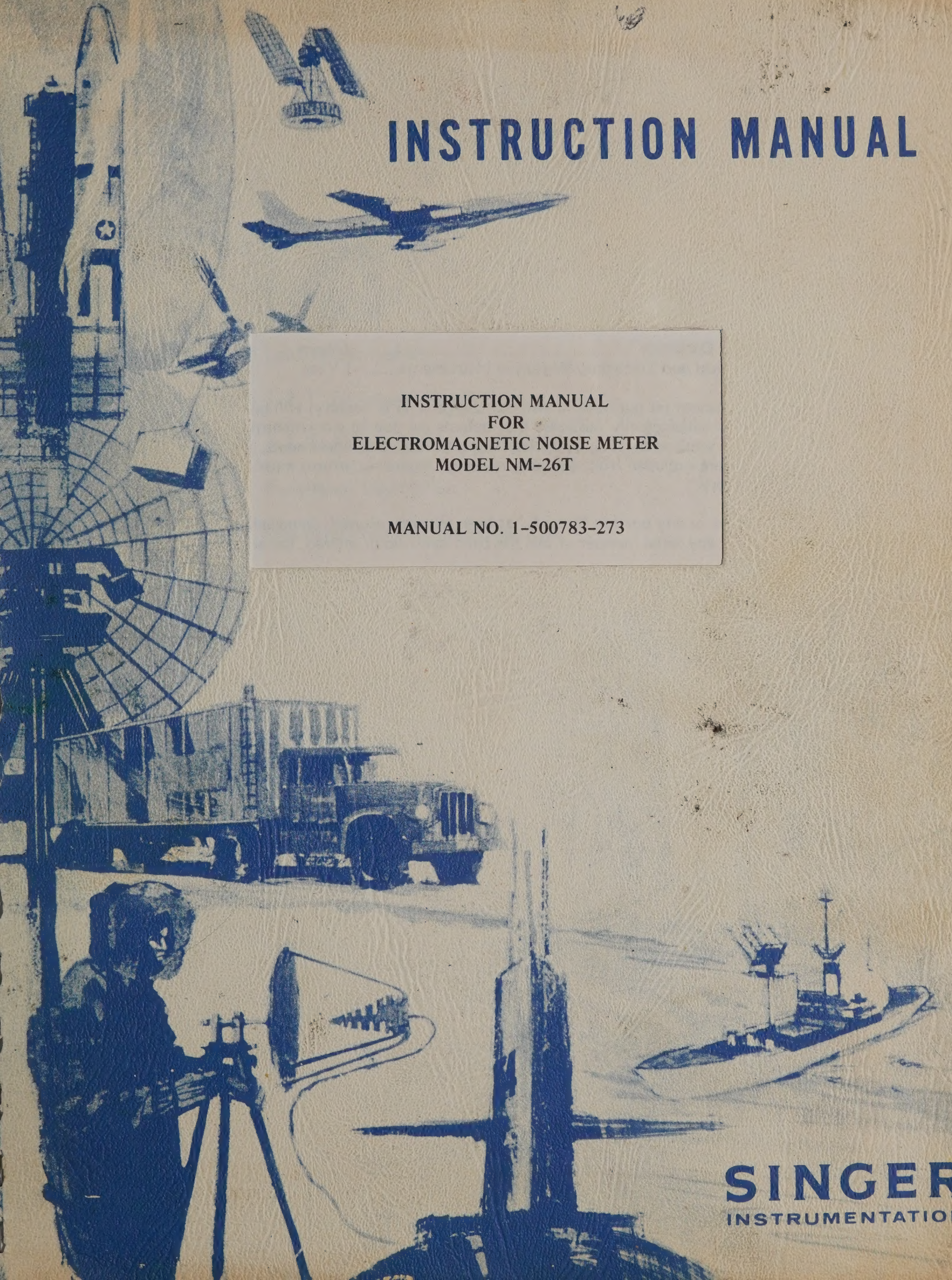
FOR
ELECTROMAGNETIC NOISE METER
MODEL NM-26T

MANUAL NO. 1-500783-273



SINGER
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SINGER	NM-26T
SINGER INSTRUMENTATION LOS ANGELES, CALIF. MADE IN U.S.A.	SERIAL NO. 0622-07076

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MANUAL CHANGES
SEE ADDENDUM(S) AT
REAR OF THIS MANUAL

SINGER
INSTRUMENTATION

The Singer Company, Los Angeles Operation • 3211 South La Cienega Blvd., Los Angeles, Ca. 90016

WARRANTY

SINGER INSTRUMENTATION, LOS ANGELES OPERATION, (SELLER) warrants each new instrument to be free from defects in material and workmanship, effective after delivery to the original purchaser as follows:

TCXO Oscillator .... 2 Years
Electrical and Electronic Measuring Instruments....... 1 Year

Repair or replacement (at our option) without charge (F.O B. factory) will be effected when our examination satisfactorily indicates that defects are due to workmanship or materials. Electron tubes, semiconductors, batteries, fuses, lamps, thermoelements, and RatioTran potentiometers are excluded from warranty coverage. Warranty returns must first be authorized by the factory.

If the instrument or any portion thereof, has been abused, misused, damaged by accident or negligence, or if any serial number or seal has been removed or altered, the warranty is void.

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With respect to repairs, the foregoing warranty shall apply for a period of ninety days to the repaired portion.

THE SINGER COMPANY, LOS ANGELES INSTRUMENTATION OPERATION
3211 South La Cienega Boulevard, Los Angeles, California 90016

REPAIR AND MAINTENANCE

Instruments should be returned only on prior authorization from the Singer Representative or the factory. You will be advised of detailed shipping instructions at that time. Return the instrument to the factory Prepaid. Validity of warranty will be determined by the factory.

Chargeable repairs: If requested, an estimate of charges will be made prior to repairs. Please provide us with the following information in order to expedite the processing of your instrument:

1. Model or Type
2. Serial Number
3. Description of trouble(1)
4. Approximate date instrument was placed in operation.
5. Approximate number of hours in use.
6. Has maintenance action been previously requested.
7. Other comments.

(1) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken and any other relevant data.

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Section I

DESCRIPTION AND LEADING PARTICULARS

1.1 INTRODUCTION

This manual contains operation and maintenance instructions for the Model NM-26T Electromagnetic Noise Measuring Set. The manual is divided into six sections; i.e., Description and Leading Particulars, Preparation for Operation, Operating Instructions, Principles of Operation, Maintenance, and a Parts List.

1.2 LEADING PARTICULARS

The NM-26T Electromagnetic Noise Measuring Set, hereafter referred to as the EN Meter, is a portable test instrument for measuring and analyzing either conducted or radiated RF energy between 150 kHz and 32 MHz. Operating power is obtained from an internal battery, rechargeable from any 105 to 125, or 210 to 250 volt, 50 to 400 Hz source. With the available accessory items, the instrument can be used for the following applications:

a. Conducting man-made radio noise surveys to locate the source and/or to analyze the nature of conducted and radiated interference.

b. Performing field intensity measurements to assist in adjusting directional antennas, or to investigate radiation patterns where field strength may vary widely.

c. Making laboratory measurements using the instrument as a sensitive, calibrated, two-terminal, tunable RF voltmeter.

1.2.1 Equipment Supplied

The equipment supplied is listed in Table 1-1.

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Table 1-1. Equipment Supplied

ITEM	SINGER NUMBER	DESCRIPTION
1	NM-26T ✓	Electromagnetic Noise Meter, 150 kHz to 32 MHz SN 0622-07076
2	93861-1 ✓	Battery Pack
3	91258-1 ✓	AC Power Cable, 6-foot
4	1-500783-273 ✓	Instruction Manual.

1.2.2 Accessory Items Available

The available accessory items are listed in Table 1-2.

Table 1-2. Accessory Items

ITEM	SINGER NUMBER	DESCRIPTION
1	92191-1	RF Transmission Line, 20-foot
2	92191-2	RF Transmission Line, 2-foot
3	92197-3	Rod Antenna, Remote, 41 inches
4	92198-3	Antenna Coupler
5	92192-3	Antenna Coupler Adapter, high impedance
6	92199-3	Ground Plane(used with 92197-3 and 92198-3)
7	92200-3 ✓ SN 0429	Loop Antenna, Remote
8	93410-1	Mounting Adapter, Loop Antenna
9	91550-1	RF Current Probe

Table 1-2. Accessory Items (Continued)

ITEM	SINGER NUMBER		DESCRIPTION
10	11663		Coaxial Connector (N to BNC)
11	90799-3	90799-1	Loop Probe
12	10796		Headphones
13	90078-14		Remote Meter*
14	90071-1		Oscilloscope or X-Output Cable
15	90074-1		Headphones Extension Cable, 20-foot
16	90075-2		Remote Meter Cable, 20-foot
17	90075-4		Remote Meter Cable, 6-foot
18	91933-2		Tripod
19	92049-1		Tripod Bag (Holds one tripod)
20	93854-1		Meter Transit Case
21	92220-4		Accessory Case
22	91981-2		Cable Bag
23	93049-1	SN 160	Rod Antenna, 9-foot, with Coupler
24	91263-1		Impulse Generator
25	91987-2		Graphic Milliameter Recorder (60 Hz)
26	90075-1		Recorder Cable, 6-foot

*Remote meter scale must be calibrated with the NM-26T at factory.

1.3 FUNCTIONAL DESCRIPTION

The NM-26T EN Meter is a sensitive, calibrated radio receiver, which functions as an RF voltmeter, tunable from 150 kHz to 32 MHz. An internal impulse generator is used for standardizing the overall gain at the frequency of measurement. The EN Meter contains solid-state circuitry throughout, and is compact, light-weight, and mechanically rugged. Modular construction and printed circuits are used for all major sub-assemblies.

A self-contained, rechargeable battery provides completely portable operation. A built-in battery charger circuit, operating from an AC power source, is provided. If desired, the battery can be charged with the instrument turned off. Also, the EN Meter can be operated from an AC power source with the battery removed. A battery meter scale monitors the battery voltage, and warns the operator when the battery is discharged. The battery charger automatically prevents overcharging. The EN Meter has an input impedance of 50 ohms when used as a two-terminal RF voltmeter. It can be used in this configuration to measure RF voltages from 0.1 uV to 1.0 volt. The EN Meter can be used for field intensity measurements from 1.0 mV/meter to 10 or more volts/meter by connecting the rod antenna and antenna coupler. Field intensity measurements can also be made by connecting the loop antenna, and orienting the loop for maximum pickup.

The EN Meter is basically an eight-band superheterodyne receiver having special built-in signal measurement capabilities. It employs single conversion for Bands 3, 4, and 5 and double conversion for the remaining bands. The following measurement functions can be selected by the front panel FUNCTION switch:

a. NOISE: This is the normal operating function for the receiver. In this position,

the level of noise power (rms voltage) is indicated on the main meter, while the quantity V_d is indicated on the V_d-Battery meter. This function can also be used to observe signal modulation envelopes with an oscilloscope connected to the SCOPE output receptacle.

b. FIELD INTENSITY: This function is identical to the Noise function except that the V_d-Battery meter is used to indicate the amount of charge left in the battery. This is the function which might be used to monitor a signal, when V_d is not required.

c. PEAK: In this position the receiver gain is controlled manually using the PEAK control. As the gain is adjusted, the rms meter indicates the signal level which must be exceeded to cause the PEAK indicator to deflect. At the same time, the V_d meter indicates the dB difference between the average signal level and the level indicated on the rms meter. This arrangement can be used to simultaneously measure the peak and the difference between the peak and average.

The FUNCTION switch has two additional positions; i.e., BFO and CAL. Placing the switch in the BFO position permits audible reception of CW type signals. Placing the switch in the CAL position permits calibration, or standardization, of the receiver gain.

The EN Meter outputs can be monitored at the front panel receptacles. AUDIO, IF OUTPUT, RMS-OUTPUT, X-OUTPUT, V_d-OUTPUT and SCOPE receptacles are provided. Graphic recordings may be made with a graphic recorder connected to the RMS-OUTPUT receptacle.

1.4 CHARACTERISTICS AND SPECIFICATIONS

1.4.1 Electrical Characteristics

1.4.1.1 Frequency Range. 150 kHz to 32 MHz in eight bands, as follows:

BAND	FREQUENCY COVERAGE
1	150 to 305 kHz
2	290 to 590 kHz
3	560 to 1150 kHz
4	1.1 to 2.25 MHz
5	2.1 to 4.3 MHz
6	4.1 to 8.4 MHz
7	8.0 to 16.5 MHz
8	15.5 to 32.0 MHz

1.4.1.2 Type of Receiver. Superheterodyne; single or double conversion, depending on frequency range selected.

1.4.1.3 Type of Signal Capabilities. CW or amplitude modulated carrier, pulse, impulse or random interference.

1.4.1.4 Input Impedance. 50 ohms (coaxial) with an input VSWR less than 1.2.1.

1.4.1.5 Attenuator Range.

SWITCH POSITION	ATTENUATION (dB)		METER READING (dB Above 1 uV)	
	RF	IF	MIN	MAX
-20 dB/ x 0.1	0	0	-20	+20
0 dB/ x 1.0	0	20	0	+40
+20 dB/ x 10.0	20	20	+20	+60
+40 dB/ x 10^2	40	20	+40	+80
+60 dB/ x 10^3	60	20	+60	+100
+80 dB/ x 10^4	80	20	+80	+120

NOTE:
IF attenuation is 20 dB with the FUNCTION switch in the CAL position.

1.4.1.6 Sensitivity. Depends on use, input device, and frequency, as follows:

a. TWO-TERMINAL RF VOLTMETER: Nominally 0.1 uV, or -127 dB above 1 mW across 50 ohms for unity signal-to-noise ratio.

b. FIELD INTENSITY METER: Sensitivity will vary with frequency and input device:

1. Rod Antenna and Coupler: 1 uV/meter to 15 uV/meter

2. 15-inch Loop Antenna: 5 uV/meter to 100 uV/meter.

1.4.1.7 Intermediate Frequency. Bands 1, 2, 6, 7 and 8, employ double conversion, with the first IF at 1600 kHz, and the second at 455 kHz. Bands 3, 4, and 5, employ single conversion, with the 455 kHz IF.

1.4.1.8 Selectivity. 5.0 kHz impulse bandwidth nominal

1.4.1.9 Spurious Response Rejection. Image rejection is better than 50 dB; IF and all other spurious response rejection is better than 60 dB.

1.4.1.10 Local Oscillator Radiation. Less than 100 picowatts.

1.4.1.11 Shielding Effectiveness. Better than 100 dB.

1.4.1.12 Crest Factor. 10:1 minimum, full scale rms output meter.

1.4.1.13 Calibration. Internal impulse generator with a fixed repetition rate of approximately 500 pps and spectral output constant over entire frequency range.

1.4.1.14 Measurement Functions.

a. NOISE: rms voltage measurement, all types of signal modulation envelopes. The V_d indicator (see (d) below) is active.

b. F.I.: Same as the NOISE function except the V_d indicator (see (d) below) is disabled.

c. PEAK: Manually controlled slideback peak detector; visual indicator employs a moveable "white bar" meter. The V_d indicator (see (d) below) is active.

d. V_d: Ratio between rms and average voltage in NOISE position and ratio between average and peak voltage in PEAK position of function switch.

1.4.1.15 Measurement Accuracy. Frequency as read on dial is within ±2%; voltage measurements are within ±1.5 dB.

1.4.1.16 RMS Panel Meter. Four-inch scale length; calibrated in two decade scale from 0 to plus 40 dB above 1 microvolt rms.

1.4.1.17 V_d/BATTERY Panel Meter. 1 1/2 inch scale length; calibrated in one decade linear from 0 to 20 dB, and linear 12 to 17 volts battery.

1.4.1.18 Outputs. Six, as follows:

a. AUDIO: Headphone receptacle; 600 ohm impedance; output power 20 mW minimum; frequency response flat within ±3 dB from 250 Hz to 2500 Hz. With 50 ohm impedance, output power is 100 mW minimum.

b. X-OUTPUT: BNC coaxial receptacle; approximately 1.4 volt dc for maximum frequency dial rotation.

c. IF OUTPUT: BNC coaxial receptacle; high impedance; 455 kHz IF available; output voltage 0.025 volt rms minimum.

d. SCOPE: Oscilloscope BNC coaxial receptacle; impedance greater than 500 kilohms; output voltage 20 mV p-p with 30% modulation; frequency response flat within ±6 dB from 100 to 2500 Hz.

e. V_d-OUTPUT: Two-pole receptacle for remote meter, or graphic recorder; 1500 ohm output impedance; output current 1 mA maximum.

f. RMS-OUTPUT: Two-pole receptacle for remote meter, or graphic recorder; 1500 ohm output impedance; output current 1 mA maximum.

1.4.1.19 Power Source. Internal rechargeable NiCd battery of 12 "C" size cells and 1.9 ampere-hour capacity. The nominal voltage is 14 to 17 volts DC, and provides an operating time of 40 hours without recharging. A BATTERY voltage meter is provided, equipped with a 12 to 17 volt expanded scale. An internal regulator circuit provides 12 volts dc, ±0.1 volt, to the EN Meter.

1.4.1.20 Battery Charger. The charger will operate from any source of 105 to 125, or 210 to 250 volts, 50 to 400 Hz. Power consumption is 5 watts, and the charger circuit provides a maximum charging current of 150 mA when the battery is fully discharged. A trickle charge current of 40 to 60 mA is provided when the battery is fully charged. Charging time is 30 hours with the EN Meter not operating, and 44 hours with the meter ON.

1.4.2 Physical Specifications

The Model NM-26T EN Meter is 8-3/4 inches high, 14-3/4 inches wide, and 7-3/4 inches deep. With batteries installed, the unit weighs 22-1/2 pounds.

Section II

PREPARATION FOR OPERATION

2.1 GENERAL

This Section describes preparation of the NM-26T for measurement of conducted or radiated RF signals at any desired location. Actual operating instructions are given in Section III.

2.2 SELECTION OF A MEASUREMENT LOCATION

Radio frequency noise or field intensity measurements often must be made at a designated location. In such cases, the operator must be aware of the effects that surrounding terrain, and nearby metallic objects may have on the radiation to be measured. However, when the location can be chosen, the operator must know how to choose the best location for a particular type of measurement.

Regardless of where the measurements are made, the EN Meter will indicate the true field intensity at each location. For best results, measurement locations must be as far as possible from sources of spurious electromagnetic interference. Also, greatest accuracy is obtained when the measurement location is at least two wavelengths away from the source of the radiation to be measured. Otherwise, the measurement may be affected by induction field components superimposed upon the radiation component.

When selecting a measurement location, the operator must realize that the amplitude of the RF voltage induced into the rod or loop antenna will be directly proportional to the field intensity of the radiated electromagnetic field---in the space occupied by the antenna. The rod and loop

antenna each respond only to the vertical component of the electromagnetic field, and are therefore calibrated in terms of the vertical component. Once the measurement location is decided upon, the field intensity is governed by the following factors:

a. The output power of the radiating source.

b. The directional characteristics of the radiating source.

c. The frequency of the radiation.

d. The distance between the radiating source, and the measurement location.

e. Reflections from the earth, atmosphere, or nearby objects.

2.3 POWER REQUIREMENTS

2.3.1 Power Sources

The EN Meter operates from an internal rechargeable battery, both during portable use and also when connected to an external ac power source. When an external ac power source is used, the built-in battery charger charges the battery. For convenience, the battery may also be charged without turning the EN Meter ON, and the unit may be operated from the battery charger with the battery removed.

2.3.2 Battery Charger

The battery charger operates from any single-phase ac power source of 105 to 125, or 210 to 250 volts, 50 to 400 Hz. The power line selector switch on the left side of the EN Meter front panel must be set to the correct position. Also located on the left isde of the front panel are the POWER receptacle, power line fuses, and the POWER switch (CHARGE - OFF - ON). A six-foot power cable connects the POWER receptacle to the ac power line. The battery charger regulator prevents overcharging by maintaining the charging current within rated values.

2.3.3 Battery

The internal battery consists of a 12-nickel cadmium cells, Sonotone type S104, size "C". The battery is located in an aluminum case in the power supply compartment. The BATTERY meter on the upper left corner of the front panel monitors the battery voltage whenever the POWER switch is set to the CHARGE or ON positions. The EN Meter can be operated for approximately 40 hours from a fully charged battery before the battery needs recharging.

2.4 SETTING UP THE EQUIPMENT

2.4.1 Basic Test Configuration

The NM-26T EN Meter is an extremely versatile test instrument, and can be connected with its accessory items in many different ways. However, the following are the basic test configurations:

a. The EN Meter can be mounted on the tripod, and either the rod antenna and antenna coupler, or the loop antenna, can be mounted on top of the EN Meter.

b. The EN Meter can be placed on a bench, or other flat surface, and the rod antenna and antenna coupler installed on the ground plane. The ground plane can be mounted on the tripod and located up to 20 feet from the EN Meter. If the loop antenna is used, it can be mounted directly on the tripod.

c. The EN Meter can be connected to 50 ohm, high impedance, or current probe input sources for measurement of conducted signals. It can also be connected to a loop probe input device to detect radiation leakage from shielded enclosures.

2.4.2 Adjusting the Tripod

Adjust the tripod as follows:

a. Loosen the lower knobs on all three legs, and adjust the extension sections for the desired height.

b. Tighten the lower knobs to lock the extension sections in place.

c. Loosen the upper knobs on all three legs, and spread the legs to the position that provides greatest stability.

d. Tighten the upper knobs to lock the legs in place.

2.4.3 Preparing the EN Meter for Use

Prepare the EN Meter for use as follows:

a. Mount the EN Meter on the tripod, or place it on a bench or other flat surface.

b. If an external ac power source of 105 to 125, or 210 to 250 volts, 50 to 400 Hz is available, the EN Meter can be connected to the ac power source as follows:

1. Set the 105 V - 125 V/ 210 V - 250 V switch on the front panel to the position corresponding to the available line voltage.

2. Connect one end of the six-foot ac power cable to the POWER receptacle on the front panel of the EN Meter. Connect the other end to the ac power source.

2.4.4 Connecting the RF Cable

Either the two-foot or 20-foot RF cable may be used. Both are coaxial cables with BNC connectors at each end. The two-foot RF cable is used when either the rod or loop antenna is mounted on top of the EN Meter. The 20-foot RF cable is used when either the rod or loop antenna is mounted on the tripod. The 20-foot RF cable is also used whenever the RF current

probe or RF loop probe are used as the signal pickup devices. A longer 50 ohm impedance RF cable may be used if desired.

One end of the cable is connected to the RF INPUT receptacle on the front panel of the EN Meter, and the other end is connected to the signal pickup device. For conducted measurements, the other end can be connected directly to any 50 ohm signal source - provided that the total dc plus RF power does not exceed 0.5 watt. This end can be connected to higher or lower impedance signal sources if an impedance mismatch can be tolerated.

2.4.5 Connecting the Loop Antenna

Mount the loop antenna on top of the EN Meter by means of the Mounting Adapter (93410-1). Fasten the antenna in place by tightening the screws on the base of the Mounting Adapter.

Mount the EN Meter (with attached loop antenna) on the tripod so it may be rotated. Loosen the center knob on the tripod and rotate the EN Meter to the desired antenna orientation position, then tighten the center knob.

When the loop antenna is to be located remotely from the EN Meter, mount the loop assembly directly on the tripod by adjusting the center knob. The antenna can then be oriented to any desired position around the tripod vertical axis. Use the 20-foot RF cable to connect the loop antenna to the RF INPUT receptacle on the EN Meter.

2.4.6 Connecting the Rod Antenna, Antenna Coupler, and Ground Plane

The 41-inch telescopic rod antenna must be attached to the antenna coupler, and extended to its maximum length during use. The antenna coupler, in turn, must be connected to the RF

INPUT receptacle on the EN Meter. The antenna coupler matches the relatively high impedance of the rod antenna to the 50 ohm input impedance of the EN Meter in each of the eight bands. The rod antenna and antenna coupler can be mounted on top of the EN Meter, or they can be attached to the ground plane and mounted on the tripod, if desired.

Attach the rod antenna to the insulated coaxial fitting on top of the antenna coupler. Mount the rod antenna and antenna coupler on top of the EN Meter, and connect the antenna coupler to the RF INPUT receptacle on the EN Meter with the two-foot RF cable.

When the rod antenna and antenna coupler are to be located remotely from the EN Meter, attach the coupler to the ground plane using two 8-32 screws. Connect the antenna coupler to the RF INPUT receptacle on the EN Meter with the 20-foot RF cable.

Since the ground plane is not large enough to constitute a true signal-ground, it may be enlarged by attaching a network of radial wires or equivalent conductors for field intensity measurements of better accuracy. Up to 24 wires can be attached to the ground plane. The length of each attached radial wire must equal, or exceed, the height of the antenna. The rod antenna factors (see Figure 3-1 for typical example) are valid only when a true signal ground is used.

2.4.7 Preparing for Conducted Measurements

The EN Meter and accessories can be connected for conducted measurements from 50 ohm, high impedance, or a current probe input source.

2.4.7.1 50 Ohm Input. Connect the equipment as follows:

a. Prepare the EN Meter as described in paragraph 2.4.3.

b. Connect one end of the 20-foot RF cable to the RF INPUT receptacle on the EN Meter.

CAUTION

Do not connect the RF INPUT receptacle to signal sources exceeding 5 volts (ac or dc).

c. Connect the other end of the 20-foot RF cable to the 50 ohm signal source to be measured. Use the proper cable adapters.

d. In cases where an impedance mismatch can be tolerated, the other end of the 20-foot RF cable may be connected to higher or lower impedance signal sources. When directly measuring the output of a transmitter, first connect a tunable notch filter between the transmitter output, and one end of the 20-foot RF cable. Carefully tune the filter to the transmitter's fundamental frequency to obtain maximum rejection. Do this before connecting the other end of the 20-foot RF cable to the RF INPUT receptacle. Observe the CAUTION following step "b" above.

2.4.7.2 High Impedance Input. For conducted measurements from a high impedance input source, connect the equipment as follows:

a. Connect one end of the 20-foot RF Transmission Line (92191-1) to the RF INPUT receptacle on the EN Meter.

b. Connect the other end of the RF Transmission Line to the output receptacle on the Antenna Coupler (92198-3).

c. Attach the Antenna Coupler Adapter, high impedance (92192-3) to the Antenna Coupler. (Use the N to BNC Adapter if necessary.)

CAUTION

The peak input voltage applied to the Antenna Coupler Adapter, high impedance, must not exceed 500 Vdc, and the input power must not exceed 0.5 watts.

2.4.7.3 Current Probe Input. For conducted measurements from an RF Current Probe input source, connect the equipment as follows:

a. Connect one end of the 20-foot RF Transmission Line (92191-1) to the output receptacle of the RF Current Probe. (Use the N to BNC Adapter.)

b. Connect the other end of the RF Transmission Line to the RF INPUT receptacle on the EN Meter.

c. Open the probe and place it around the conductor, or cable group, to be tested. Be sure to center the conductor in the probe "window."

CAUTION

If the conductor to be tested is not insulated, de-energize the conductor before attaching the RF Current Probe.

d. Lock the jaws of the probe by tightening the thumbscrew (or other clamping means provided).

NOTE

Do not allow the RF Current Probe or cable connectors to make electrical contact with the ground plane, or nearby conductors. Also, do not place the probe near strong permanent magnets, or the field structure of motors or generators.

2.4.8 Connecting the Loop Probe

The loop probe is used in detecting electromagnetic radiation leakage from shielded enclosures. Its main advantage is that it can be used in areas where limited accessibility prevents the use of other signal pickup devices. Calibration figures are not given for the loop probe because it is intended primarily for relative indications, rather than actual signal measurement. To connect the loop probe, proceed as follows:

a. Prepare the EN Meter as described in paragraph 2.4.3.

b. Connect one end of the 20-foot RF cable to the loop probe. Connect the other end to the RF INPUT receptacle of the EN Meter.

2.5 CONNECTING EXTERNAL RECORDERS

2.5.1 Milliammeter Recorder

Signal amplitude or V_d can be plotted against time by connecting a milliammeter recorder (91987-2) to the EN Meter. Any suitable recorder may be used, but it must have an input resistance of 1500 ohms, and 1 mA must produce full-scale meter deflection. Graph paper used with the recorder can be calibrated in dB, or a correction rule, or scale, can be used to convert plots made on plain paper. Proceed as follows to make the necessary electrical connections:

a. Prepare the EN Meter as described in paragraph 2.4.3.

b. Connect one end of the Recorder Cable (90075-1) to the milliammeter recorder. Connect the other end to the RMS-OUTPUT receptacle of the EN Meter for signal amplitude or to V_d OUTPUT for the ratio between rms and average voltage in decibels.

2.5.2 X-Y Plotter

Signal amplitude can be plotted against frequency by connecting an X-Y plotter to the EN Meter. Any suitable X-Y plotter can be used, but the X-input resistance must be 100 kilohms or greater, and the Y-input resistance must be 1500 ohms.

NOTE

> Most X-Y plotters have high X and Y input resistance. However, an external 1500 ohm loading resistance may be used to obtain the necessary Y-input resistance.

The X output voltage of the EN Meter is proportional to the indicated dial frequency throughout each band. The maximum X output voltage for any given band is 1.0 volt dc, and the maximum Y (rms output) voltage is 1.5 volts dc. The X and Y-pole sensitivities of the plotter must be adjusted to these voltages. The Y-axis scale of the plotter must be calibrated with respect to the EN Meter.

Proceed as follows to make the necessary electrical connections:

a. Prepare the EN Meter as described in paragraph 2.4.3.

b. Connect one end of the X-output cable to the X-input receptacle of the recorder. Connect the other end to the X-OUTPUT receptacle of the EN Meter.

c. Connect one end of the 6-foot Remote Meter cable to the Y-input receptacle of the recorder. Connect the other end to the RMS-OUTPUT receptacle of the EN Meter.

2.6 PRELIMINARY ADJUSTMENTS

2.6.1 Electrical Adjustments

Each NM-26T EN Meter is carefully aligned and calibrated before leaving the factory. No

further internal adjustments are necessary. However, the following checks should be made periodically to verify that the instrument is operating properly:

a. Prepare the EN Meter as described in paragraph 2.4.3.

b. Set the POWER switch to the OFF position, and check to see that the pointer on the front panel meter is exactly at mechanical zero. If not, correct by adjusting the screw on the front of the meter case.

c. Leave the ac power cable disconnected, and rotate the POWER switch to the ON position. Rotate the FUNCTION switch to either FI or BFO position. Check to see that the V_d METER/BATTERY meter reads in the white portion of the battery volts scale. If not, the battery must be recharged. (See Section III.)

CAUTION

Do not operate the EN Meter from a discharged battery, or the battery may be damaged.

d. Rotate the ATTENUATOR to the plus 80 dB position (no RF input connected). Check to see that the panel meter pointer deflects to the left of the mechanical zero with the CAL control maximum counterclockwise.

e. Rotate the FUNCTION switch to the CAL position, and set the BAND switch to BAND 1.

f. Obtain the calibration figure for BAND 1 from the Data Section, see Data tab. Standardize the gain for BAND 1 by rotating the CAL control clockwise until the panel meter reading equals the calibration figure.

NOTE

The ATTENUATOR position has no effect on calibration.

g. Standardize the gain for the remaining bands by repeating steps "e" and "f" for each band.

h. Connect the rod or loop antenna, and plug a headset into the front panel AUDIO receptacle. Place the FUNCTION switch in the NOISE or FI position, and tune through each band. Adjust the ATTENUATOR for an "on-scale" reading on the panel meter, and the AUDIO control for a comfortable headset level. Listen for signals to verify that the RFI Meter is receiving on each band.

i. Proceed as follows to check the operation of the slideback PEAK indicator.

1. Tune the EN Meter to any modulated RF signal. Place the FUNCTION switch in the PEAK position and rotate the PEAK control fully clockwise. Check to see that the moveable white bar of the visual peak meter moves all the way to the right (clockwise).

2. Rotate the PEAK knob slowly counterclockwise and check to see that the moveable white bar of the visual peak meter starts to move to the left (counterclockwise).

k. Normal operation of the V_d circuit may be checked as follows:

1. Apply a CW signal to the EN Meter and tune for maximum response, using the NOISE position of the FUNCTION switch and the X10 position of the RF ATTENUATOR.

2. Vary the signal level from 9 dB to 40 dB on the rms meter scale, noting the V_d indication which should return to zero dB at each signal level.

3. Rotate the FUNCTION switch to CAL position. The V_d meter indication should indicate approximately 7 dB.

2.6.2 Orienting the Loop Antenna

One of the most useful properties of the loop antenna is that is can be used to obtain the

approximate bearing of a signal source. However, before it can be used for this purpose, it must be oriented toward a true magnetic north bearing. This is accomplished as follows:

a. Prepare the EN Meter as described in paragraph 2.4.3.

b. Mount the loop antenna on the tripod and connect it to the RF INPUT receptacle of the EN Meter.

c. Loosen the locknut on the tripod platform, and verify that the loop antenna is free to rotate around a vertical axis on the tripod head.

NOTE

Remove metal objects from pockets and remove magnets and tools from the vicinity before reading the magnetic compass in the following step.

d. Orient the plane of the loop in a "North-South" direction using a magnetic compass. The readings on the azimuth scale directly in line with the loop frame are at 90 and 270 degrees, respectively. Mark these points on the rim of the tripod head. These marks can then be used as a "North-South" reference line.

2.7 TRANSPORTING THE EQUIPMENT

The EN Meter and accessories can be stored in the transit cases when the equipment is not in use. The transit cases are intended for transportation of the equipment from one measurement location to another.

Section III

OPERATING INSTRUCTIONS

3.1 INTRODUCTION

This Section contains a description of the EN Meter controls and receptacles, instructions for using the signal input devices, operating instructions, calibration instructions, and instructions for charging the internal battery. The term "signal" as used in the text refers to any RF voltage applied at the RF INPUT receptacle on the EN Meter front panel.

3.2 CONTROLS AND RECEPTACLES

All external operating controls of the EN Meter are located on the front panel. For a description of the front panel controls and receptacles, see Table 3-1. All internal adjustments are described in Section V.

Table 3-1. EN Meter Controls and Receptacles

CONTROL OR RECEPTACLE	POSITION	FUNCTION
ATTENUATOR	---	Selects total signal attenuation in six steps, from -20 to +80 dB, as follows:
	-20 dB/x 0.1	Does not attenuate RF or IF signal. Signal input is one tenth of meter reading in microvolts.
	0 dB/x 1	Does not attenuate RF signal, but <u>does</u> attenuate IF signal by 20 dB.
	+20 dB/x 10	Attenuates both RF and IF signal levels by 20 dB.
	+40 dB/x 10^2	Attenuates RF signal by 40 dB, and IF by 20 dB

Table 3-1. EN Meter Controls and Receptacles (Continued)

CONTROL OR RECEPTACLE	POSITION	FUNCTION
ATTENUATOR (Continued)	+60 dB/x 10^3	Attenuates RF signal by 60 dB, and IF by 20 dB.
	+80 dB/x 10^4	Attenuates RF signal by 80 dB, and IF by 20 dB
FUNCTION	---	Selects measurement functions as follows:
	CAL	Disconnects RF input and energizes impulse generator to standardize receiver gain.
	NOISE	Processes signal to permit measurement of rms value of input signals. Also provides measurement of V_d, ratio between rms and average voltage in dB.
	FI	Same as NOISE position only V_d is not indicated.
	PEAK	The AGC voltage level is manually controlled for slideback peak signal measurement. V_d meter now indicates dB difference between the average signal level and the level indicated on the rms meter.
	BFO	Places beat frequency oscillator in operation to permit audible reception of CW signals.
BAND	---	Selects tuned circuits for Bands 1 through 8.
TUNING	---	Controls the main tuning capacitor in RF tuner; tunes the receiver within the selected band.
POWER (switch)	---	Three-position switch, as follows:
	CHARGE	Turns on the battery charging circuit, and charges the battery when the power cable is plugged into the power line.
	OFF	Removes power from the equipment.
	ON	Applies power to the equipment, and charges the battery when the power cable is plugged into the power line.

Table 3-1. EN Meter Controls and Receptacles (Continued)

CONTROL OR RECEPTACLE	POSITION	FUNCTION
105 to 125 V 210 to 250 V	---	Power line selector switch. A retaining plate holds the switch in the selected position, showing only the selected input voltage.
V_d ZERO	---	Adjusts V_d meter indicator to zero dB on a cw signal.
RMS (Switch)	---	Three position toggle switch; determines the time constant of the rms integrator amplifier and indicating meter response as follows:
	SHORT	Provides a nominal 0.1 second time constant
	MED	Provides a nominal 25 second time constant
	LONG	Provides a nominal 100 second time constant
V_d (Switch)	---	Three position toggle switch; determines the time constant of the average integrator amplifier and V_d indicating meter response as follows:
	SHORT	Provides a nominal 0.1 second time constant
	MED	Provides a nominal 25 second time constant
	LONG	Provides a nominal 100 second time constant
CAL	---	Adjusts the overall gain of the receiver during calibration.
AUDIO (control)	---	Adjusts level of audio output.
POWER (receptacle)	---	AC power input receptacle.
RF INPUT	---	RF signal input receptacle.
SCOPE	---	Oscilloscope connection receptacle for visual monitoring
RMS-OUTPUT	---	Receptacle for connection of milliammeter recorder or remote meter.

Table 3-1. EN Meter Controls and Receptacles (Continued)

CONTROL OR RECEPTACLE	POSITION	FUNCTION
V_d - OUTPUT	---	Receptacle for connection of milliammeter recorder or remote meter.
X-OUTPUT	---	Provides a dc voltage indicating tuning dial frequency in each band.
AUDIO (receptacle)	---	Headset receptacle for aural monitoring.
IF OUTPUT	---	Provides output signal from IF amplifier.
GROUND	---	Binding post for connection of an external ground.

3.3 OPERATING INSTRUCTIONS

The NM-26T instrument measures broadband noise and narrowband signals in terms of rms envelope voltage and (simultaneously) V_d, the ratio between rms and average envelope voltages. These parameters are particularly useful in relating broadband noise measurements to system performance criteria. One may regard the rms value as giving the amount of noise, while V_d indicates the type of noise (i.e., how impulse the noise is).

3.3.1 Measurement Capabilities

The NM-26T has the following functions on the FUNCTION switch: CALIBRATE, NOISE, F.I., PEAK, and BFO. These functions and their operation will be discussed in the following paragraphs.

CALIBRATE: In this position, an internal impulse generator is fed into the input to the receiver. The CALIBRATE control is used to set the rms meter indication to a calibration setting provided in the data sheet. This adjusts the gain of the RF and IF amplifiers so that the input signal voltage may be read

directly from the rms meter. In this position, the V_d-Battery meter reads V_d, the ratio between rms and average voltage (in decibels). For the mercury relay impulse generators, this reading will be near 13 dB; for solid-state impulse generators the reading will be near 7 dB.

NOISE: This is the normal operating function for the receiver. In this position, the level of noise power (rms voltage) is indicated on the main meter, while the quantity V_d is indicated on the V_d-Battery meter. The audio output should be constantly used to check that the received signal is completely noise; i.e., that is it not mixed with any intentionally transmitted cw signals, etc.

FIELD INTENSITY: This function is identical to the NOISE function except that the V_d-Battery meter is used to indicate the amount of charge left in the battery. This is the function which might be used to monitor a signal, when V_d is not required. Battery drain is slightly less in this position since the V_d circuitry is turned off.

PEAK: In this position the receiver gain is controlled manually using the PEAK control. As the gain is adjusted, the rms meter indicates the signal level which must be exceeded to cause the PEAK indicator to deflect. At the same time, the V_d meter indicates the dB difference between the average signal level and the level indicated on the rms meter. This arrangement can be used to simultaneously measure the peak and the difference between the peak and average. It is also valuable for calibrating the reading on the V_d meter.

BFO: In this position a BFO is injected into the IF, making cw signals audible, etc. The V_d-Battery meter indicates the battery charge state. THE RMS METER DOES NOT READ ACCURATELY IN THIS POSITION due to the amount of signal injected by the BFO. This position is particularly

useful for detecting the presence of a cw signal during a noise measurement. Often a low level cw signal cannot be heard in the presence of impulsive noise, but it can affect the measurement considerably. Use of the BFO will help to resolve this problem.

3.3.1.1 Other Controls and Outputs

AUDIO: A 45-ohm speaker or earphones may be plugged into the audio receptacle when using any of the above functions. The output level is controlled by the AUDIO gain control, up to a maximum of about 1/4 watt. It is particularly important to continually monitor noise measurements, listening for discrete signals in the passband which will add to the noise, giving erroneous readings.

CHART RECORDER OUTPUTS: Outputs for 1 mA 1500 ohm chart recorders are provided for both meters. (THESE OUTPUTS ARE FLOATING. NONE OF THE WIRES CAN BE ALLOWED TO COME IN CONTACT WITH GROUND OR EACH OTHER.)

TIME CONSTANTS: Short, medium, and long time constants have been provided for rms and V_d. These time constants range between 0.1 sec and 100 sec. One should use the shortest time constant possible which will not cause the meter readings to change more than a couple of decibels over the time interval in which one is sampling the data. In the case of a very continuous noise source like a fluorescent light, this would mean that the short time constant could be used. In the case of making measurements alongside a highway, where cars were passing every 15 sec, one would have to use the long time constant. Special circuitry causes the unused time constants to rapidly follow the chosen time constant. This feature means that one can cause the long time constant to rapidly approach its final value by switching to the

short time constant for a little while and then back to the long time constant. This technique is particularly useful after changing input attenuation when measuring with the long time constant.

3.4 CALIBRATION INSTRUCTIONS

The NM-26T EN Meter is calibrated (gain standardized) at the desired measurement frequency as follows:

a. Prepare the EN Meter as described in Section II (paragraph 2.4.3).

b. Set the POWER switch to the ON position.

c. Set the BAND switch to the proper band, and rotate the TUNING control for the desired frequency.

d. Set the FUNCTION switch to the CAL position.

e. Calibration figures for the EN Meter are given in the DATA section at the back of this handbook; see Data tab. Refer to this to find the proper calibration figure for the selected band.

f. Adjust the CAL control so that the rms meter reads the correct calibration figure.

> EXAMPLE: Assume an RF input signal at 250 kHz. Rotate the BAND switch to BAND 1 and tune the EN Meter to the signal frequency. Rotate the FUNCTION switch to CAL, and refer to the DATA section for the calibration figure for BAND 1. If the data gives a calibration figure of 10 dB, adjust the CAL control for a reading of 10 dB on the dB scale of the panel meter.

3.4.1 RMS Value Measurements

Either conducted or radiated RF signals may be measured in terms of the RMS value of the

signal level. Perform the measurements as follows:

a. Using the proper signal input device, connect the signal to be measured to the RF INPUT receptacle of the EN Meter.

b. Calibrate the EN Meter at the signal frequency, as described in paragraph 3.4.

c. Rotate the FUNCTION switch to either NOISE or FI position.

d. Tune the EN Meter to the signal frequency and adjust the ATTENUATOR for an "on-scale" meter reading. Rotate the TUNING knob back and forth to peak the meter reading.

e. Readjust the ATTENUATOR if necessary, to keep the meter reading in the upper portion of the scale. Record the ATTENUATOR setting and the meter reading in dB above 1 microvolt rms.

f. Record the V_d value in dB from the V_d-Battery meter.

3.4.2 Peak Value Measurements

Peak value measurements are made by visual indication only. Perform the peak measurement as follows:

a. Perform steps "a" and "b" of paragraph 3.4.1.

b. Set the FUNCTION switch to PEAK position.

c. Rotate the PEAK control fully clockwise, and set the ATTENUATOR so the moveable white bar on the visual peak meter moves in a clockwise direction.

d. Slowly rotate the PEAK control counterclockwise until the moveable white bar on the visual peak meter is vertical. Observe the reading on the panel meter as the threshold point is reached.

e. If the reading on the panel meter is "off-scale", set the ATTENUATOR to the next higher position and repeat steps "c" and "d".

f. If the reading on the panel meter falls in the lower portion of the scale, set the ATTENUATOR to the next lower position and repeat steps "c" and "d".

g. Record the ATTENUATOR setting and the reading on the rms meter at the threshold point as the peak signal level in rms of a sine wave equivalent terms.

h. Record the V_d value in dB. This will be the ratio of the average voltage to the peak signal level. This can exceed 20 dB for low repetition rate impulse signals.

3.5 SIGNAL MEASUREMENT

3.5.1 General Considerations

RF signals may be measured in rms or peak values. For unmodulated RF carriers, the NOISE, F.I. and PEAK detector functions will provide identical meter readings. When measuring carriers that are amplitude modulated by speech signals, the NOISE and FI functions provide identical meter readings, while the PEAK function will indicate up to a 2 dB greater reading depending on the percent of modulation. When measuring modulation components consisting of sharp pulses having a low repetition rate, the NOISE and FI meter readings will be very low. Under these conditions, the use of the PEAK function is preferred.

3.5.2 50 Ohm Conducted Measurements

When the EN Meter is used as a two-terminal RF voltmeter across 50 ohms, signal levels are indicated in terms of dB above 1 uV. Refer to Section II, paragraph 2.4.7.1, for specific instructions and general precautions. For measurements in dB above 1 uV, add the meter reading in dB to the ATTENUATOR factor (-20 to +80 dB).

EXAMPLE: With an ATTENUATOR setting of 40 dB and a meter reading of 26 dB, the signal level is 40 + 26 = 66 dB above 1 uV rms.

Refer to Table 3-2 for converting dB values to microvolt values.

3.5.3 High Impedance Conducted Measurements

When the EN Meter (with the antenna coupler and adapter) is used as a two-terminal, high impedance RF voltmeter, signal levels in dB above 1 uV may be found by adding a dB correction factor to the sum of the meter reading and ATTENUATOR factor (both in dB). The correction factor is obtained from the High Impedance Factor Chart (see Figure 3-1 for sample). Refer to Section II paragraph 2.4.7.2 for specific instructions and general precautions.

EXAMPLE: With a 6.8 MHz conducted signal, the high impedance factor is 22 dB. An ATTENUATOR setting of 40 dB and meter reading of 26 dB result in a signal level of 40 + 26 + 22 = 88 dB above 1 uV rms. This can be converted into uV by referring to the Conversion Table (Table 3-2).

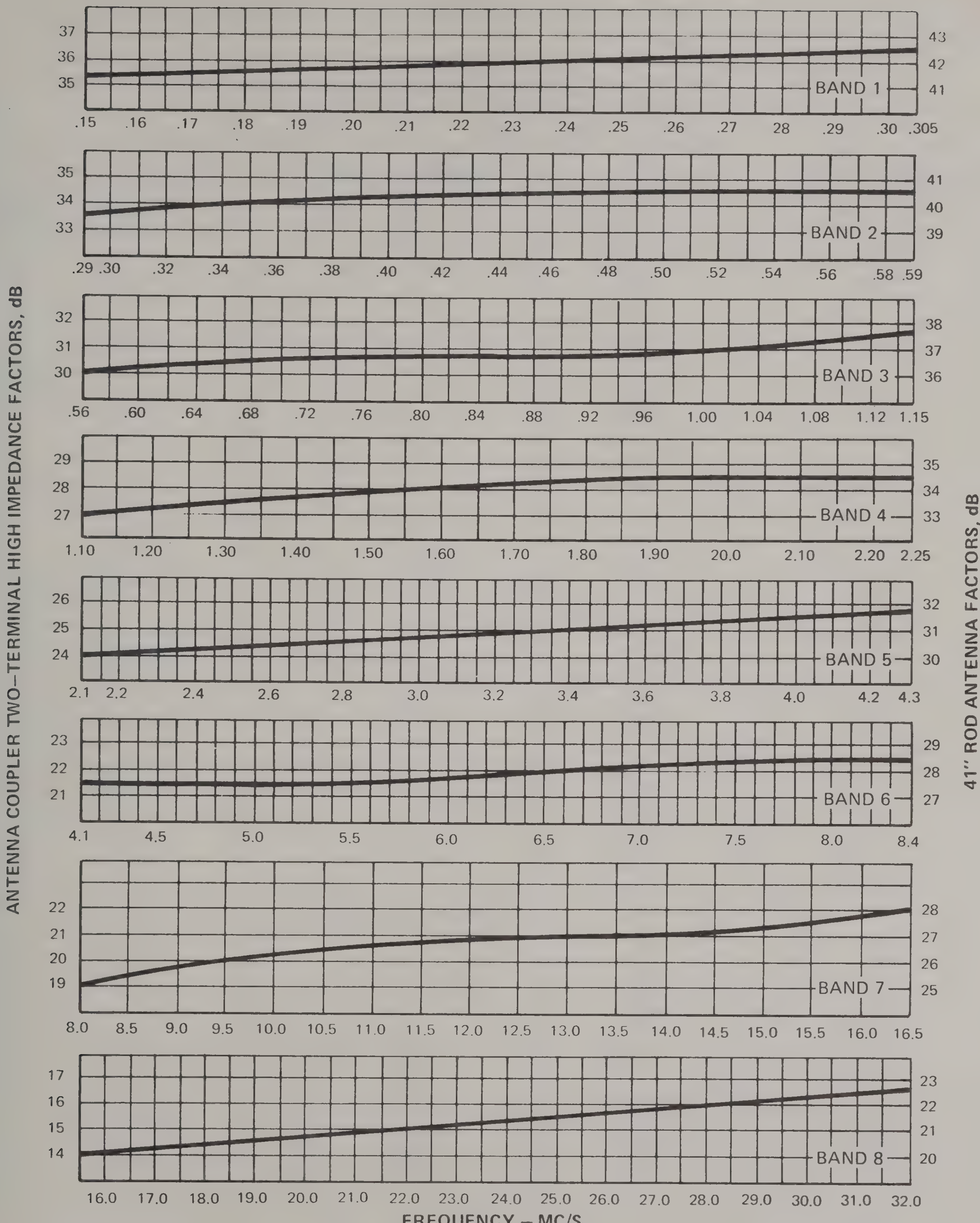
3.5.4 RF Current Probe Conducted Measurements

The RF current probe is a broadband RF transformer than can be used for measuring RF currents in a cable or conductor without physically disturbing the circuit. Signal levels can be computed in terms of microamperes (uA) or dB above 1 UA. Refer to Section II, paragraph 2.4.7.3 for specific instructions and general precautions.

3.5.4.1 Measurements in dB above One Microampere

For measurements in dB above 1 uA, proceed as follows:

a. Adjust the EN Meter for standard gain and measure the signal in dB above 1 uV.



CALIBRATED BY: ____________________

DATE: ______________

FOR SINGER 92198–3 ANTENNA COUPLER

SERIAL NO.: SAMPLE ONLY

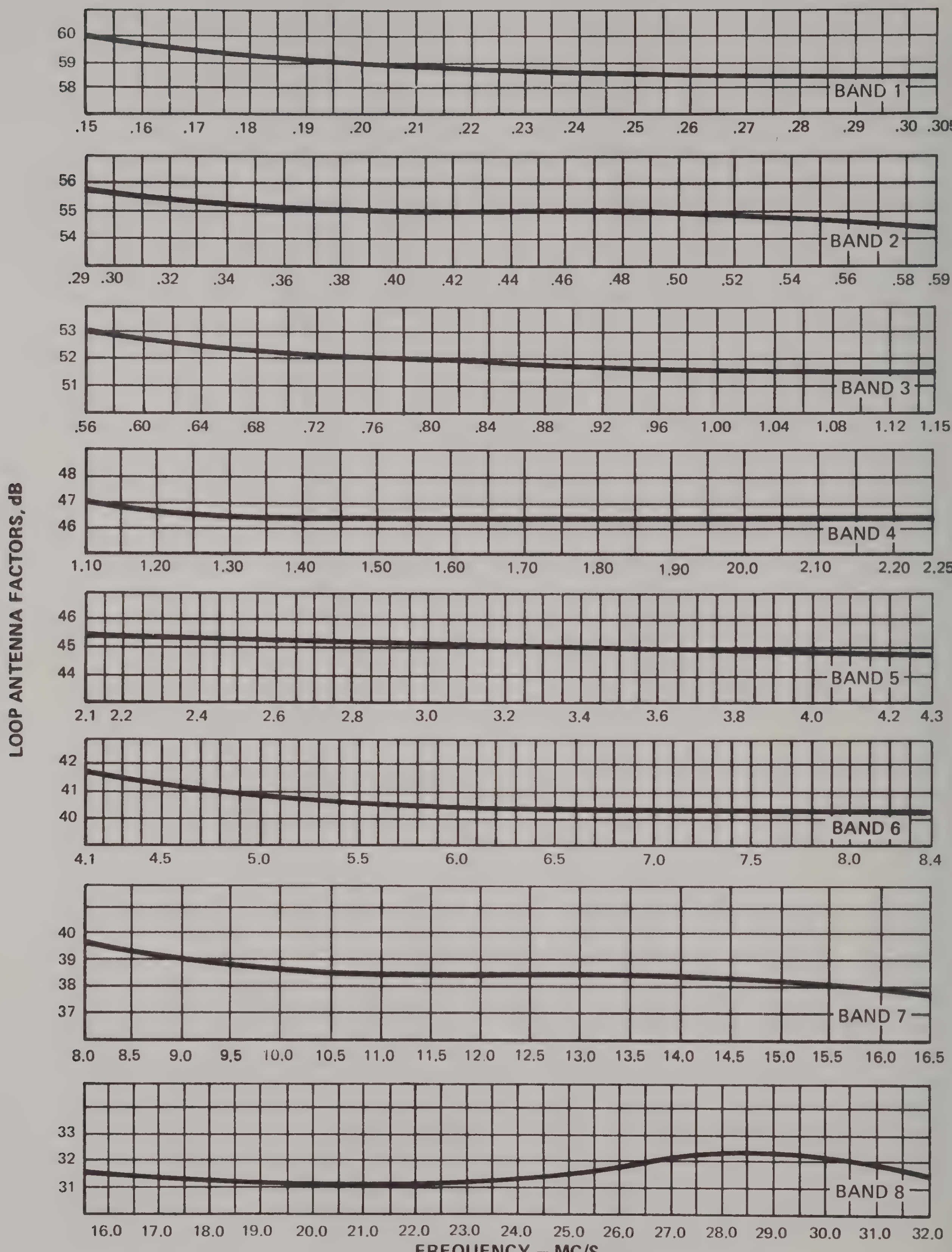
Figure 3-1. Typical Rod Antenna and High Impedance Factors

CONVERSION TABLE 3-2

dB Above 1 µV	µV	dB Above 1 µV	µV
-20	0.100	16	6.31
-19	0.112	17	7.08
-18	0.126	18	7.94
-17	0.141	19	8.91
-16	0.159	20	10.00
-15	0.178	21	11.20
-14	0.200	22	12.60
-13	0.224	23	14.30
-12	0.251	24	15.90
-11	0.282	25	17.80
-10	0.316	26	20.00
- 9	0.355	27	22.40
- 8	0.398	28	25.10
- 7	0.447	29	28.20
- 6	0.501	30	31.60
- 5	0.562	31	35.50
- 4	0.631	32	39.80
- 3	0.708	33	44.70
- 2	0.794	34	50.10
- 1	0.891	35	56.20
0	1.00	36	63.10
1	1.12	37	70.80
2	1.26	38	79.40
3	1.41	39	89.10
4	1.59	40	100.00
5	1.78	**dB Above 1 µV**	**mV**
6	2.00	41	0.112
7	2.24	42	0.126
8	2.51	43	0.141
9	2.82	44	0.159
10	3.16	45	0.178
11	3.55	46	0.200
12	3.98	47	0.224
13	4.47	48	0.251
14	5.01	49	0.282
15	5.62	50	0.316

CONVERSION TABLE 3-2 (Continued)

dB Above 1 μV	mV	dB Above 1 μV	mV
51	0.355	86	20.00
52	0.398	87	22.40
53	0.447	88	25.10
54	0.501	89	28.20
55	0.562	90	31.60
56	0.631	91	35.50
57	0.708	92	39.80
58	0.794	93	44.70
59	0.891	94	50.10
60	1.00	95	56.20
61	1.12	96	63.10
62	1.26	97	70.80
63	1.41	98	79.80
64	1.59	99	89.10
65	1.78	100	100.00
		dB Above 1 μV	Volts
66	2.00	101	0.112
67	2.24	102	0.126
68	2.51	103	0.141
69	2.82	104	0.159
70	3.16	105	0.178
71	3.55	106	0.200
72	3.98	107	0.224
73	4.47	108	0.251
74	5.01	109	0.282
75	5.82	110	0.316
76	6.31	111	0.355
77	7.08	112	0.398
78	7.94	113	0.447
79	8.91	114	0.501
80	10.00	115	0.562
81	11.20	116	0.631
82	12.60	117	0.708
83	14.10	118	0.794
84	15.90	119	0.811
85	17.80	120	1.000



CALIBRATED BY: ______________________

DATE: ______________

FOR SINGER 92200–3 LOOP ANTENNA

SERIAL NO. SAMPLE ONLY

Figure 3-2. Typical Loop Antenna Factors

b. Determine the transfer impedance of the current probe in dB at the test frequency (from the graph in the current probe instruction manual). Subtract this from the dB value in step "a". The answer is the value of the conducted signal in dB above 1 uA in the test sample lead.

EXAMPLE: Assume a frequency of 200 kHz, a measured signal of 52 dB above 1 uV, and a transfer impedance of -8.0 dB above 1 ohm at 200 kHz. Then, as outlined in step "b": 52 dB -(-8.0 dB) = 60 dB above 1 uA rms in test sample lead.

3.5.5 Radiated Signal Measurements

When the rod or loop antenna are used, a dB correction factor must be applied. This figure is added to the sum of the meter reading in dB and the ATTENUATOR factor in dB to obtain the signal level in dB above 1 uV per meter. Sample correction factors are given in the Rod Antenna Factor Chart (Figure 3-1), and the Loop Antenna Factor Chart (Figure 3-2).

EXAMPLE: With the rod antenna as the signal pickup device, the antenna factor is 28 dB when measuring a 6.8 MHz signal. If the ATTENUATOR setting is 40 dB, and the meter reading 26 dB, the signal level is 40 + 26 + 28 = 94 dB above 1 uV rms per meter.

3.5.6 Conversion of Units

Signal levels in dB above 1 uV can be converted directly into microvolts or millivolts from the Conversion Table, 3-2. The table covers a range of -20 to +120 dB above 1 uV, in steps of 1 dB.

EXAMPLE: A radiated signal level of 95 dB above 1 uV per meter can also be expressed as 56.2 mV per meter.

3.5.7 Measuring Sinusoidal RF Signals in the Presence of High Level Interference

When a sine wave RF signal must be measured in the presence of high level random interference, the interference can be compensated for, and the amplitude of the RF signal can be estimated with reasonable accuracy. The procedure for finding the signal level in uV is given on the Correction Chart, Figure 3-3.

> EXAMPLE: With a "noise-plus-signal" meter reading to 50 uV, a "noise-only" reading of 30 uV, and an ATTENUATOR setting of x 1, the corrected signal value from Figure 3-3 is 40 uV.

3.6 MEASURING BROADBAND SIGNALS

A broadband signal is characterized as having a spectral output that is wide with respect to the bandwidth of the receiving system. Broadband signals are considered to be: (1) random, (2) impulsive, or (3) mixtures of these two. A random signal is characterized by overlapping pulses that are randomly spaced and random in amplitude. An impulse signal is one or more electrical disturbances having a duration in seconds much less than the reciprocal of the EN Meter bandwidth in Hertz, and the interval between the impulses is such that one has died out before the next one starts (no overlapping).

The V_d reading indicates how impulsive the signal is. A cw signal registers 0 dB. Pure Gaussian or random noise registers between 0 dB and 1 dB. A purely impulse signal will register in excess of 20 dB. Generally, for low V_d signals, the NOISE detector function provides the more useful measurement with a PEAK measurement contributing little additional information. At higher V_d levels both rms and PEAK measurements should be recorded.

CORRECTION CHART FOR SINE WAVE SIGNALS IN THE PRESENCE OF HIGH AMBIENT INTERFERENCE OF RANDOM NATURE

1. Adjust for standard gain at the frequency of the incoming "signal." Rotate FUNCTION switch to FIELD INTENSITY.

2. Note the meter reading of the interferring "noise" in the absence of sine wave signal. If necessary, detune slightly off signal.

3. Tune signal for maximum meter reading and note reading of signal and interferring "noise" combined.

4. Locate the meter reading of "noise plus signal" on horizontal scale of chart.

5. Follow the arc upward until it intersects the horizontal line which represents the "noise only" meter reading.

6. Drop down from the point of intersection to the horizontal scale and read off the corrected meter reading.

7. This is the value of the sine wave signal in the absence of "noise".

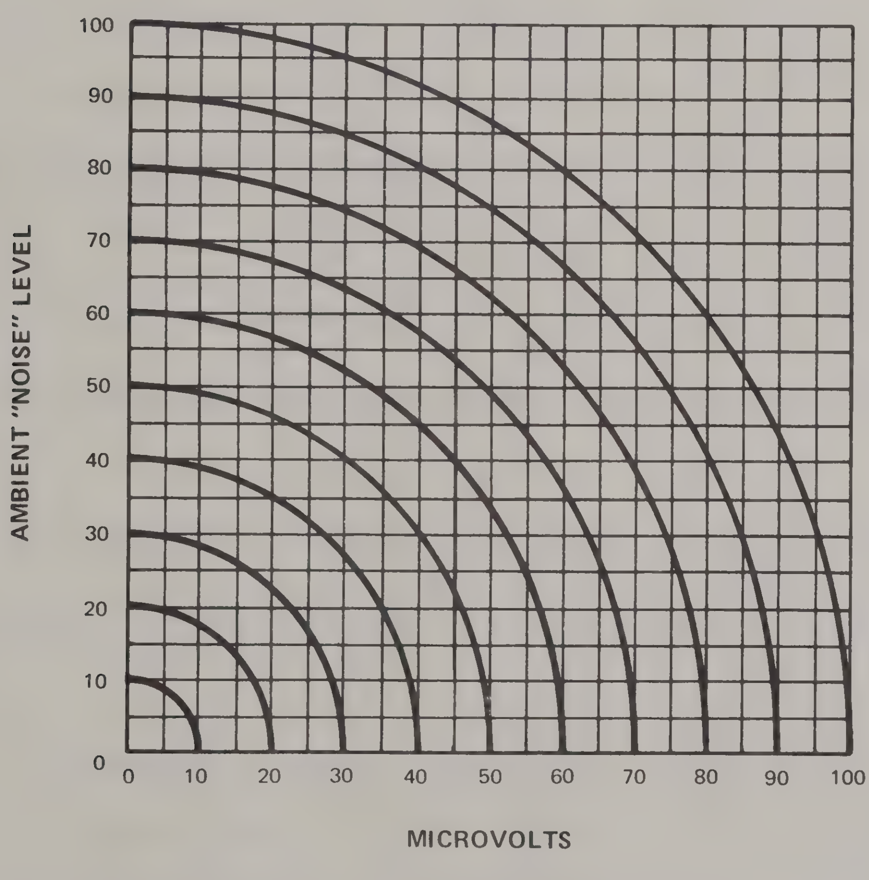


Figure 3-3. Correction Chart for Sine Wave Signals in the Presence of High Level Random Interference

Conversion of a broadband signal measurement into a per unit bandwidth value (i.e. - dBuV/kHz) is occasionally required so measurements made with instruments of different bandwidths can be directly compared. This conversion differs, depending on the type of broadband signal, random or impulse.

Random Noise Signal. For random noise (low V_d measurements) the conversion factor, Kr, that is applied to the measurement to obtain uV/kHz terms is:

$$Kr = \frac{1}{\sqrt{BWr}}$$

where:

BWr = random noise bandwidth of the EN meter in kHz

(See data section.)

Apply the Kr factor to measurements made in the NOISE or F.I. positions of the FUNCTION switch. This factor may be converted to a dB value ($20 \log_{10} Kr$) and added to dBuV measurements.

EXAMPLE: (Conducted measurement.) Assume a NOISE function meter indication of 30 dB, an ATTENUATOR setting of 0 dB, and a random noise bandwidth of 3.2 kHz. Then:

$$Kr = \frac{1}{\sqrt{3.2}} = 0.559 = -5.05 \text{ dB}$$

$$E = 30 \text{ dB} + 0 \text{ dB} + (-5.05 \text{ dB}) = 24.95 \text{ dBuV/meter/kHz rms}$$

Impulse Signal. For impulse signals (high V_d measurements) the conversion factor, K_i, that is applied to the measurement to obtain uV/kHz terms, is:

$$K_i = \frac{1}{BW_i}$$

where:

BW_i = impulse bandwidth of the EN meter in kHz

(See data section.)

Apply the K_i factor to measurements made in the PEAK position of the FUNCTION switch. This factor may be converted to a dB value ($20 \log_{10} K_i$) and added to the dBuV measurement.

EXAMPLE: (Radiated measurement). Assume a PEAK function meter indication of 25 dB, an ATTENUATOR setting of +20 dB, a rod antenna factor of 31 dB (at 1 MHz) and an impulse bandwidth of 5.1 kHz.

Then:

$$K_i = \frac{1}{5.1} = 0.196 = -14.15 \text{ dB.}$$

$$E = 25 \text{ dB} + 20 \text{ dB} + 31 \text{ dB} + (-14.15 \text{ dB}) =$$

$$61.5 \text{ dBuV/meter/kHz rms*}$$

*This equipment has been calibrated in terms of rms of a sine wave (0.707 of true PEAK of a sine wave). PEAK values are therefore in terms of rms of a sine wave which would have the same PEAK amplitude as the impulse signal that appears at the detector input.

3.7 AC POWER SOURCE AND INTERNAL BATTERY USE

3.7.1 Operation from an AC Power Source

To operate the EN Meter from an AC power source, proceed as follows:

a. Set the 105-125V/210-250 V selector switch to the position corresponding to the AC power line voltage. A retaining plate holds this switch in the selected position, displaying the selected voltage.

b. Connect one end of the power cable to the POWER receptacle. Connect the other end to the AC power source.

c. Set the POWER switch to the ON position.

During operation from an AC power line the internal battery is being charged, and the battery voltage is monitored on the BATTERY VOLTS scale on the V_d METER/BATTERY meter when the FUNCTION switch is in F.I. or BFO positions. The expanded BATTERY VOLTS scale (12 to 17 volts) of the meter increases the accuracy of the battery voltage reading.

3.7.2 Operation from an AC Power Source with the Internal Battery Removed

The EN Meter can be operated from an AC power source with the internal battery removed by following the instructions given in paragraph 3.9.1. The power supply inside the EN Meter produces a regulated 12 volts. The BATTERY meter may read slightly above full scale without an internal battery, but this will not damage the meter.

3.7.3 Operation from the Internal Battery

To operate the EN Meter from the internal battery, set the POWER switch to ON. Check the battery condition by observing the BATTERY meter. The BATTERY meter reading should be in the white portion of the scale. If the meter reading is in the red portion of the scale, the

battery is discharged, and the EN Meter must be switched OFF to avoid battery damage.

A fully charged battery can operate the equipment for up to 40 hours without recharge.

3.7.4 Charging the Internal Battery

Twelve rechargeable 1.25 volt NiCd battery cells, Sonotone Type S104-C, are series connected and housed in an aluminum case. When charging a fully discharged battery, the battery voltage at first rises fast, then starts to stabilize. When the battery is charged to 50 percent of its capacity, the battery voltage remains nearly constant. When discharging a fully charged battery, the voltage at first drops fast, then remains nearly constant until the cells are almost completely discharged. At this time, when the voltage drops sharply, the discharge should be stopped. If the battery is left unused in fully or partially charged condition, a slight discharge occurs, but this is not detrimental to the battery.

WARNING

When operating from an AC power line, do not turn the equipment off by pulling the power plug or throwing the bench power switch. Always place the EN Meter power switch in the OFF position.

Section IV

PRINCIPLES OF OPERATION

4.1 GENERAL

This Section covers the principles of operation of the NM-26T EN Meter. The information is presented to assist the user in understanding the circuitry employed in the EN Meter, and is especially useful in troubleshooting and other maintenance of the equipment. The text is referenced to the Functional Block Diagram, Figure 4-1, and the Schematic Diagrams, Figures 4-2 and 4-3.

4.2 BASIC PRINCIPLES OF OPERATION

The following discussion is based on the Functional Block Diagram, Figure 4-1, and provides a section-by-section description of the equipment. The EN Meter is basically a super-heterodyne receiver, with several additional circuits to provide the necessary measurement functions. This discussion emphasizes the various control functions in operation of the equipment.

4.2.1 EN Meter Requirements

An EN Meter can be defined as a frequency selective two-terminal RF voltmeter. The NM-26T EN Meter is designed to measure various types of signals, as are normally encountered in the portion of the spectrum covered by the equipment.

The EN Meter contains an accurately calibrated step attenuator circuit, permitting the overall measurement range to be extended beyond the capabilities of the panel meter. An impulse generator is contained within the equipment. This circuit provides a spectral output over the tuning range of the equipment that is of known level. This, in turn, permits the gain of the EN Meter to be standardized at the measurement frequency. This is important in obtaining

repeatable data between measurements. The final major difference between the EN Meter and a conventional receiver is in the detector functions employed.

4.2.2 EN Meter Description

The EN Meter may be divided into six basic sections. These are: the input section, RF section, IF section, rms detector section, audio and Vd section, and power supply.

4.2.2.1 Input Section. The input section consists of an RF attenuator, Z101, low-pass filter, Z102, and the impulse generator, Z103.

The input signal at the RF INPUT receptacle is applied to the RF attenuator. The RF attenuator is mechanically linked with the IF attenuator, with the two operating in conjunction with each other to provide the total signal attenuation.

The RF attenuator has six step positions, selected by the ATTENUATOR knob. The overall range of the ATTENUATOR is -20 dB to +80 dB. The RF section of the attenuator is "straight through" in the first two positions (-20 dB and 0 dB). In each of the succeeding four positions, the RF attenuation at the input is increased by 20 dB (the IF attenuator is "straight through" in the -20 dB position, and 20 dB in all other positions of the ATTENUATOR knob).

From the RF attenuator, the input signal is applied to the CAL switch, S106A. This switch is mechanically linked with the FUNCTION switch, S103. In all positions of S103 except CAL, the input signal is applied through the low-pass filter to the RF tuner. However, in the CAL position S106A selects the output of the impulse generator instead, and applies this to the RF tuner to provide the gain standardization function.

The impulse generator consists of a blocking oscillator, Q135, and switching amplifier, Q136,

energized in the CAL position. The switching amplifier alternately charges and discharges a delay line, DL101, to produce a pulse output. The pulse output is then applied through an attenuator network and the CAL switch, S106B, to the low-pass filter, Z102.

4.2.2.2 RF Section. The RF section consists of the RF tuner, A101, and the IF converter, Z113.

The RF tuner, in turn, consists of two RF amplifiers, a mixer, and a local oscillator. The tuner covers the frequency range of 150 kHz to 32 MHz in eight bands. The tuner circuits for each of these bands are on individual tuner boards, mounted in a turret configuration, and selected by the BAND knob. Frequency selection within an individual band is by means of a 4-gang variable capacitor, driven by the tuning knob.

The input signal is amplified by Q101 and Q102, and applied to the mixer, Q103. Output of the local oscillator, Q104, in turn is injected into the mixer, heterodyning to produce the desired IF applied to the IF converter. This may be either 1600 kHz or 455 kHz, depending on the position of the BAND switch. Bands 1 and 2, and 6 through 8, employ a 1600 kHz IF, while Bands 3 through 5 employ a 455 kHz IF.

The IF signal is applied through the converter switch, S101, and appropriate tuned circuits, to Q105. Again, depending on the BAND switch position, Q105 functions either as a 455 kHz IF amplifier, or as a 1600/455 kHz mixer (in conjunction with the second local oscillator, Q106).

The output from Q105 is applied through a 455 kHz filter, T138 and T139, across the CAL control, Z114. The CAL control is used to standardize the EN Meter gain. From the CAL control, the signal is applied through the IF attenuator, Z115, to the IF amplifier section, Z116.

4.2.2.3 IF Section. The IF section, Z116, consists of the 455 kHz IF amplifiers, second detector, and BFO.

The first two stages, Z107 and Q108, are AGC controlled. The AGC voltage is applied to voltage variable capacitance diode controlled transformers, T147 and T140 respectively, at the input of these stages. The output from Q108 is applied through a double tuned filter, T141 and T142, to Q109. The filter in turn assists in establishing the desired IF response.

When the FUNCTION switch is set to the BFO position Q113 is energized, producing a 455 kHz signal that is injected into Q109. This permits an audible reception of CW signals.

The 455 kHz signal from Q109 in turn is applied to a push-pull output stage, Q110 and Q111, and appears across the IF output transformer, T144.

The signal at T144 is applied to the detector, and also to the IF OUTPUT receptacle. The detector CR106 and CR108, functions in conjunction with a bias oscillator, Q112. The bias oscillator operates at a frequency of 850 kHz, and the output is applied to detector diode CR106, to obtain linear detection at low signal levels.

4.2.2.4 RMS Converter – Integrator Section. In this particular rms measuring system, the rms voltage (as seen through an appropriate time constant (e.g., 10 seconds) at the output of the linear detector, CR106, is kept constant by AGC action. If the rms input signal at the antenna increases, the output of the rms converter integrator will increase. When the output of the rms converter integrator exceeds a certain reference value, the AGC voltage is adjusted to decrease

the gain of the EN Meter, restoring the output of the rms converter integrator to the reference value again. Similarly, a decrease in the input signal causes an increase in the EN Meter sufficient to return the output of the rms converter integrator to the reference level. In the absence of any input signal, the receiver gain will increase until the receiver front end noise gives enough power to equal the reference level. Since the relationship between AGC voltage and receiver gain can be determined, and since one can also find what gain is needed so that a particular level of input signal will cause the rms converter integrator to give the reference output level, there is a known relationship between input level and AGC voltage. Therefore, one can calibrate the meter measuring the AGC voltage in terms of the input signal level.

4.2.2.5 V_d Section. The average voltage of the detector output can also be measured. Since the rms detector output is kept constant by AGC action, the average voltage which will be measured is the ratio between the (constant) rms level and the average voltage. This quantity is called V_d and is expressed in decibels with system gains adjusted so that a CW input signal of any amplitude gives $V_d = 0$ dB.

4.2.2.6 Audio Section. The demodulated IF signal from CR108 is applied across the AUDIO control, R241, and amplified by U13, which supplies the 600 ohm headset output at the AUDIO receptacle.

4.2.2.7 Power Supply Section. The EN Meter is normally operated from an internal re-chargeable 12-volt battery. A battery charging circuit is provided within the EN Meter, operating from an external ac source (either 105 to 125, or 210 to 250 volts). The battery may be charged with the equipment in operation if desired, and in addition, the EN Meter may be operated from the charger circuit with the battery removed.

The power supply, A102, consists of a line filter and transformer, and the battery charger, Z200, which in turn consists of a rectifier, charge regulator, and a voltage regulator circuit.

The external ac voltage is applied through a line filter, Z122, to a transformer, T302. The two primary windings of T302 may be connected in parallel (for 105 to 125 volt operation), or series (for 210 to 250 volt operation) by the POWER switch, S302. The secondary output from T302 is rectified by CR307 through CR310, and applied to the charge regulator circuit, Q201 and Q202. The charge regulator output is applied to the battery, Z123. The battery output is applied across a voltage regulator circuit, Q203 and Q204, which provides a regulated 12 volt output to the EN Meter circuitry. The battery voltage is monitored on the V_d METER/BATTERY meter, M103.

4.3 CIRCUIT ANALYSIS

4.3.1 Pickup Devices

The basic pickup devices consist of the rod antenna and coupler, and the loop antenna assembly, (Figure 4-2).

4.3.1.1 Rod Antenna and Coupler. The telescoping rod antenna, 92197-3, can be extended to a maximum length of 41 inches, at which point it exhibits an approximate capacity of 10 picofarads. The rod antenna represents a high impedance source compared to the 50 ohm input impedance of the EN Meter (typically 100 kilohms at 150 kHz and approximately 500 ohms at 32 MHz). Therefore, the coupler is used to match this high impedance source to the 50 ohm input of the EN Meter.

The rod antenna coupler, 92198-3, consists of a BAND switch, S401, and eight impedance matching networks, T401 through T408. The frequency ranges of the coupler bands correspond

to those of the EN Meter, with the unused positions shorted to minimize interaction.

The coupler can also be used (without the rod antenna installed) for high impedance conducted measurements. In this application, the antenna coupler adapter, 92192-3, is attached to provide connection facilities, and the input capacity remains 10 picofarads.

4.3.1.2 Loop Antenna Assembly. The loop antenna assembly consists of a single-turn 15-inch diameter loop and appropriate matching networks. The loop is electrostatically shielded, and exhibits an inductance of 0.96 microhenry. The impedance of the loop as a source varies from one ohm at 150 kHz to 200 ohms at 32 MHz.

The loop impedance is matched to the 50 ohm EN Meter input by the BAND switch, S402, and eight matching networks, T411 through T418. As in the rod antenna coupler, the frequency ranges correspond to those of the EN Meter, and the unused positions are shorted.

4.3.2 RF Input Circuits

The RF input circuits (Figure 4-3) comprise the RF attenuator, CAL switch, low-pass filter, and impulse generator. Each circuit is separately packaged, and carefully shielded to minimize pickup of noise and other interference.

4.3.2.1 RF Attenuator. The RF attenuator, Z101, consists of four attenuator networks and two straight through conductors in cylindrical housings, that are mounted around a control shaft. The control shaft is mechanically linked to the ATTENUATOR knob, which is calibrated in 20 dB steps from -20 dB to +80 dB. The input signal is applied at the RF INPUT receptacle, J101, on the front panel of the EN Meter. Receptacle J101 in turn is connected to the RF attenuator. Rotating the ATTENUATOR knob places the selected network between the input connector, J102,

and the output connector, J103. Shorting type switches are used in order to ground the input and output circuits of the remaining attenuator networks.

In the -20 dB and 0 dB positions of the ATTENUATOR, central conductors directly connect the input and output connectors of Z101.

For the remaining positions, networks are switched into the circuit. The 20 dB and 40 dB attenuators are "T" pads, and the 60 dB and 80 dB attenuators are double "T" pads. The precision resistors in the attenuators have a maximum power dissipation rating of 0.5 watt, and therefore care must be exercised that the total signal input power does not exceed this rating.

4.3.2.2 <u>CAL Switch</u>. The RF signal from the output connector of Z101 is applied to the input connector of the CAL switch assembly, S106. The CAL switch is mechanically linked with the FUNCTION switch, S103. When the FUNCTION switch is placed in any position except CAL, the output of the RF attenuator is applied through S106A and S106B to the input of the low-pass filter, Z102. In the CAL position, S106A connects the RF attenuator to ground to prevent spurious signals present at the output of the attenuator from being coupled through the capacity of the switch to the low-pass filter.

4.3.2.3 <u>Low-Pass Filter</u>. The low-pass filter, Z102, has input and output impedances of 50 ohms. The filter consists of two M-derived end sections, and two constant-K center sections. The cutoff frequency is 40 MHz, thus providing a flat response to the upper frequency limit of the EN Meter. Purpose of the low-pass filter is to reject spurious signals having frequencies beyond the normal range of the equipment. From the output of the low-pass filter, the signal is applied to the input connector of the RF tuner.

4.3.2.4 Impulse Generator. The impulse generator, Z103, constitutes a standard calibrating signal source in the EN Meter. The generator consists of a free-running blocking oscillator, switching amplifier and a section of coaxial cable used as a pulse-foming delay line.

When the FUNCTION switch is placed in the CAL position, +12 volts is applied to energize the circuit, and the delay line charges through R102 and R275. The blocking oscillator, Q135, operates at approximately 500 Hz, producing an output across the tertiary winding (pins 3 and 4) of T131. This sine wave signal is coupled through C101 to the base of the switching amplifier, Q136. On the positive half of the input cycle Q136 conducts and the collector goes negative with respect to the charge on DL101. This causes the delay line to discharge and produce a negative going output pulse across the attenuators R103 through R106. This continues until the input cycle reverses, going negative at the base of Q136 and cutting the transistor off. At this time DL101 again charges towards plus 12 volts until the next positive half cycle arrives at the base of Q136.

The output pulses from the attenuator are then applied through R109 to the CAL switch, S106B, and have a flat spectral output throughout the frequency range of the EN Meter. The output level is adjustable by potentiometer R275, and the pulses from S106B are applied to the input of the low-pass filter, Z102.

4.3.3 RF Tuner

The RF Tuner, A101, consists of two tuned RF amplifier stages, a local oscillator, and the first mixer. Incoming signals are amplified in the two tuned stages, and heterodyned in the mixer with the output of the local oscillator. The IF output of the mixer is either 455 kHz or 1600 kHz, depending upon the BAND selected by the user. From the mixer, the signal is

applied to the IF converter section, Z113.

4.3.3.1 Turret Assembly. The RF tuner contains a turret-type switching assembly with eight transformer strips, Z104 thru Z111, mounted around a control shaft. The shaft is mechanically linked to the BAND selector knob. As the BAND selector is rotated to the desired position, the proper transformer strip is switched into the RF Tuner circuits. Each transformer strip contains the tuned circuits for the two RF amplifiers, the first mixer, and the local oscillator. The resonant circuits of the selected transformer strip are tuned within the selected band by the ganged variable capacitor, C111. The capacitor has four sections, and has a ceramic shaft to minimize feedback between the two RF amplifier stages. The capacitor is rotated by the front panel TUNING knob.

4.3.3.2 RF Amplifiers. The input signal at P112 is applied through a resistive attenuator pad to the selected input transformer (T101 for BAND 1), which is tuned by C111A. Tracking in this stage is accomplished with a trimmer capacitor (C121 for BAND 1), and the signal is applied to the base of the first RF amplifier, Q101. Forward bias for Q101 is derived from a voltage divider composed of R116 and stabistor CR101. The signal at the collector of Q101 is then applied through either a low-pass filter (Bands 1 and 2) or a tuned circuit (Bands 3 through 8) to the second RF amplifier, Q102. Bias for Q102 is derived from R118 and stabistor CR102.

The low-pass filter (L105, C123, and C124 for BAND1) is used to reject spurious high frequency signals, while the interstage tuned circuits maintain relatively constant gain and low VSWR throughout their individual tuning ranges. This is accomplished by application of loading resistances to obtain the proper bandwidth.

The signal at the collector of Q102 is applied across the selected transformer (T102 for BAND 1), which is tuned by C111C. The output from this transformer is then applied to the first mixer, Q103.

4.3.3.3 First Mixer. The input signal and local oscillator signal are heterodyned in the first mixer, Q103, to produce the IF output (either 455 kHz or 1600 kHz, depending on the selected band). The base bias for Q103 is developed across a voltage divider composed of R119 and R120, while the input and local oscillator signals are series injected to the base from the selected transformer strip. The signal at the collector of Q103 is applied to the output connector, P114, of the RF tuner.

4.3.3.4 Local Oscillator. The local oscillator, Q104, is a Hartley configuration, operating on the high side of the input frequency. The tuned circuit for this stage consists of a transformer (T103 for BAND 1)and capacitor C111D, while the base bias is developed by a voltage divider consisting of R122 and stabistors CR103 and CR104. The stabistors provide thermal stability for Q104.

4.3.4 IF Converter

The IF converter, Z113, consists of a converter switch, 1600 kHz triple tuned filter, 455 kHz tuned circuit, and IF converter/amplifier stage, and a second local oscillator stage. The IF converter functions as a 1600/455 kHz converter in the dual conversion bands (1 and 2, and 6 through 8), and as a 455 kHz IF preamplifier in the single conversion bands (3 through 5). The output from the converter is applied through a double tuned 455 kHz filter to the CAL control and IF attenuator, Z115.

4.3.4.1 Converter Switch. The converter switch, S101, is mechanically linked with the BAND switch. In the single conversion bands, the 455 kHz input at J114 is applied through S101A to the 455 kHz IF transformer, T136, and through S101B to the base of Q105. In the double conversion bands, the 1600 kHz input at J114 is applied through S101A to the triple

tuned filter, T133 through T135, and through S101B to the base of Q105. The filter reduces image response in the converter, while coupling capacitors C187 and C189 determine the bandwidth.

4.3.4.2 Double Conversion. In the double conversion bands, the 1600 kHz IF signal is injected in series with a 2055 kHz signal from the second local oscillator, Q106, to the base of the converter/amplifier, Q105. In this configuration, S101C changes the emitter bias of Q105 by shorting R159, and S101D applies +12 volts to energize Q106, connected as a crystal controlled Hartley oscillator. The tuner circuit consists of T137, C195, and C288, with the crystal, Y101, functioning at series resonance to provide a low impedance feedback path in the emitter return. Base bias for Q106 is derived from a voltage divider, R161 and R162, from the +12 volt bus, while the 2055 kHz oscillator output is coupled through C194 to the secondary of T135. The 455 kHz output signal at the collector of Q105 is applied across the double tuned 455 kHz filter, T138 and T139.

4.3.4.3 Single Conversion. In the single conversion bands, the 455 kHz IF signal is applied to the base of Q105, which then functions as a conventional IF preamplifier. The gain of Q105 in this configuration is reduced by the introduction of a fixed degeneration derived from the unbypassed emitter resistance, R159. This affords the same gain through the IF converter in both single and double conversion configurations.

4.3.5 CAL Control and IF Attenuator

4.3.5.1 CAL Control. The 455 kHz IF signal from T139 is applied across the CAL control, Z114, to standardize the gain of the EN Meter. The CAL control consists of a bridged T

attenuator network, with a double ganged potentiometer, R168A and R168B, functioning as the variable attenuator. The input and output resistances, R166 and R167, maintain a 50 ohm impedance through the control. The CAL control is completely shielded to minimize any pickup of noise and/or interference.

4.3.5.2 IF Attenuator. The IF attenuator, Z115, is mechanically linked with the RF attenuator (paragraph 4.3.2.1), and the FUNCTION switch, S103. The IF attenuator is a fixed 20 dB, 50 ohm pi-network, consisting of R169 through R171. When the ATTENUATOR knob is set to the -20 dB position, S102 disconnects the pi-network, and the IF signal passes directly to the main IF amplifier, Z116. In all other positions of the ATTENUATOR knob, S102 switches the IF attenuator into the signal path. However, when the FUNCTION switch is in the CAL position, the IF attenuator is in the signal path regardless of the ATTENUATOR knob setting. For any given ATTENUATOR setting, the total signal attenuation is the sum of both the RF and IF attenuation.

4.3.6 IF Amplifier

The IF amplifier, Z116, consists of three single-ended IF stages, a push-pull IF output stage, a bias oscillator, and the second detector. AGC is applied to the first two stages.

4.3.6.1 AGC Loop. The AGC loop functions with two levels; i.e., the AGC control voltage, and the AGC reference voltage. The AGC control voltage is obtained from the output of U6 in all FUNCTION switch positions except PEAK, where it is obtained from the wiper of the PEAK potentiometer, R203. The AGC reference voltage is obtained from U11.

The incoming 455 kHz IF signal is then applied across a "bridge" circuit. One side of the

bridge is connected to the AGC reference voltage, while the center, or output, is connected to the AGC control voltage. The basic bridge circuit is a transformer, T147, having two bifilar wound secondaries. A pair of voltage variable capacitance diodes, CR116 and CR117, are connected in series between the two secondaries, with the output taken at the junction of the diodes.

In a balanced condition, the 455 kHz signals in the secondary windings cancel, and the output at the junction is "zero". However, in an unbalanced condition the 455 kHz signals will not completely cancel, and an IF output appears at the junction of the diodes. The degree of unbalance depends on the difference between the AGC control voltage and the AGC reference voltage.

An amplitude increase in the RF signal produces a corresponding increase in the level of AGC control voltage. This in turn causes the bifilar secondary windings of the transformer to approach a balanced condition, attenuating the IF signal at the junction of the diodes. Conversely, a decrease in amplitude of the RF signal decreases the level of AGC control voltage, and an unbalanced condition across the secondary windings, in turn reducing the IF signal attenuation.

4.3.6.2 AGC Controlled Stages. The 455 kHz signal from the IF attenuator, Z115, is applied to the primary winding of T147. The secondary output at the junction of CR116 and CR117 is then applied through C282 to the base of Q107. Base bias for Q107 is derived from a voltage divider, R220 and R268. The output from the collector of Q107 is then applied across the primary of T140, which functions in the same manner as T147 (paragraph 4.3.6.1) to provide AGC action to the IF signal.

The secondary output of T140, at the junction of CR118 and CR119, is then applied through C281 to the base of Q108, the second IF amplifier. The output of Q108 is appliedto a low-impedance tap on T141 to prevent excessive collector loading. The AGC reference voltage is applied to the two "pin 4" terminals of T140 and T147, while the AGC control voltage is applied to Q107 and Q108 through R200 and R174, respectively. Base bias for Q108 is derived from R173 and R179.

4.3.6.3 Driver Stage. Transformers T141 and T142 function as a double-tuned 455 kHz filter, with the output applied to the base of Q109. Base bias for Q109 is obtained from R176 and R180. Negative feedback is applied to the emitter of Q109 from the push-pull output stage through C202, R178 being unbypassed for this purpose. (Note: C202 must be disconnected during IF alignment to prevent the negative feedback from affecting the adjustments.)

The overload capacity of the amplifier is established by the setting of the "dynamic range" potentiometer, R187. The collector of Q109 is connected through a reverse biased diode, CR105, to the wiper of R187. Thus adjusting R187 varies the level of reverse bias applied to CR105, in turn limiting the signal peaks at the collector of Q1 09. The output from Q109 is then applied across the primary winding of T143.

4.3.6.4 Output Stage. The push-pull IF output stage, Q110 and Q111, operates in a class "B" common emitter configuration. Base bias for this stage is derived from a voltage divider consisting of R184 and R185, with CR109 providing temperature stability, and the common emitter resistance, R186, is unbypassed for degeneration.

The 455 kHz signal across the secondary of T143 is amplified by Q110 and Q111, and appears

across the primary winding of the IF output transformer, T144. The secondary of T144 is resonated by C218, and the output signal is applied to the second detector, CR106 and CR108, and is also routed through C230 to the front panel IF OUTPUT receptacle, J120.

4.3.6.5 Bias Oscillator. The second detector diodes exhibit non-linear characteristics at low conduction levels. As linear detection is required, a bias voltage is applied to the diodes in series with the IF output signal to maintain the conduction level above the non-linear region.

The bias oscillator, Q112, operates at approximately 850 kHz. The oscillatory circuit consists of T145 and C221, while base bias for Q112 is derived from a voltage divider, R188 and R189, from the +12 volt bus. The output signal across the secondary of T145 is approximately 0.3 volts rms, and is applied in series with the IF output from T144 to the detector.

4.3.6.6 Detector. Two separate detector circuits are used, CR106 and CR108. Diode CR106 applies the demodulated IF envelope to buffer amplifier U2. The output of diode CR108 is applied to the audio amplifier, with the front panel AUDIO potentiometer, R241, functioning as the diode load resistance.

4.3.7 Beat Frequency Oscillator

The beat frequency oscillator, Z112, permits audible reception of CW signals when the FUNCTION switch, S103, is set to the BFO position. This applies +12 volts dc through S103A to Q113, energizing the circuit to produce a near 455 kHz output that is capacity coupled to the IF driver stage, Q109. This in turn heterodynes with the 455 kHz IF signal

to produce an audible signal. The oscillatory circuit comprises C222 and T146, while base bias for Q113 is derived from R195 and R196. The BFO signal is decoupled from the +12 volt dc bus by a filter, composed of C225 and R198.

4.3.8 Metering Circuits

The metering circuits of Z117-1A and Z121-2A modify the detector, CR106, output in accordance with the selected measurement function. The measurement functions, selected by the FUNCTION switch, are NOISE, F.I., and PEAK. These three functions are aligned to produce the same output meter indication on a CW signal.

4.3.8.1 NOISE Function Circuit. The signal from the detector enters card Z117-1A on pin N and goes through a buffer amplifier, U2, with a gain of around -1/30. This converts the high voltage, high impedance detector output, (A), to a low voltage, low impedance signal, (B), more easily handled by the operational amplifiers. The buffered output is split, going to the rms integrator and to the V_d circuit on card Z117-2A. The rms integrator operates by squaring the signal using logarithms: V^2 = anitlog (2 log V). Diodes U1D2 and U1D3 provide a voltage proportional to 2 log V at point (C). The current through U1D5 is then proportional to antilog (2 log V) or V^2. This current is integrated according to the chosen time constant by an integrating amplifier, U4, with high gain. If the integrated current is higher than a reference value, set by a current source, Q118, opposing the current through U1D5, the output of the integrating amplifier, (E), moves in a direction to decrease the receiver gain. Thus, the integrated current (and therefore the average power) is held equal to the reference value by increasing or decreasing receiver gain as necessary. The

rms meter operates from the AGC voltage at (F), reading the AGC voltage necessary to raise the average receiver input power (rms voltage) to the reference value in the rms integrator. Since the relationship between receiver gain and AGC voltage is known, the AGC meter may be calibrated directly in terms of rms voltage. U1D4 provides temperature compensation for the log diodes (which are highly temperature dependent). Resistors R216 and R217 (10 k Ω) cause the unused time constants to track the voltage on time constant being used. They follow the time constant much more rapidly in this mode than they do in normal operation because no amplifier gain is involved in this mode. The extra resistors will not change the reading when the respective time constant is being used because (D) is adjusted to exactly the same voltage as point V, which prevents any net current from flowing through the resistors.

The buffered output from (B) also goes to the V_d function on card Z117-2A. It is integrated according to the chosen time constant, giving an integrated value of voltage at (B). The next two stages convert this average voltage to decibels, at a level suitable to drive the V_d-Battery meter. Since the average power is held constant at (B) by the action of AGC, any level of CW signal at the receiver input will cause an integrated output at (B) to be a certain fixed level. Gains are adjusted so that this fixed level reads 0 dB on the V_d meter. This says that, for any level of CW signal at the receiver input, the average envelope voltage is equal to the rms envelope voltage (i.e., there is 0 dB difference between the rms and the average voltage envelopes). A noise signal, however, is not a constant CW signal. For noise, the rms function integrates the envelope according to a different amplitude weighting function than does the average function. Now, as before, the AGC is continually adjusted so that the integrated rms voltage at (B) is a fixed value, corresponding to the reference value at point V. The

integrated average voltage at (B) is not the same as the integrated rms voltage at (B), however, The ratio between the integrated rms voltage and the integrated average voltage, expressed in decibels, is the value V_d. The average voltage is always less than the rms voltage. The greater the ratio between the rms and the average, the more impulsive the noise.

4.3.8.2 F.I. Function Circuit. The F.I. function circuit is identical to the NOISE function except card Z121-2A is partially deenergized and the V_d-Battery meter indicates battery voltage.

4.3.8.3 PEAK Function Circuit. In the PEAK position, the functions are similar to those in the NOISE position with a few exceptions. The signal goes through the buffer and the log amplifiers as before. The integrating amplifier has had the time constant removed from it, however, and the output of this amplifier goes to the peak detector. Now, any signal - even a short duration impulse - that exceeds the reference level will cause a large signal on the output of the integrating amplifier (E), which is amplified by Q119 and Q120 and causes the PEAK indicator to deflect. The AGC voltage is now derived from the PEAK control, and the rms meter indicates the setting of the AGC voltage. Recall that for measurements in the NOISE position, for any CW input, the AGC voltage (and corresponding reading on the rms meter) is exactly the AGC voltage needed to make the receiver input just equal to the referenced level at the integrating amplifier. In the peak position, the AGC voltage (and its corresponding rms meter reading) is selected manually. Any input voltage exceeding the reading on the rms meter will give a voltage greater than the rms integrator reference, giving an indication on the peak indicator.

4.3.9 Power Supply

The power supply operates the EN Meter from either a single-phase ac power source of 115 or

230 volts, 50 to 400 Hz, or from an internal rechargeable battery. When an ac power source is used, the battery is normally on charge. However, the battery can be charged without turning the EN Meter on. In addition, the EN Meter can be operated from an ac power line with the battery removed. A fully-charged battery can operate the equipment for up to 40 hours before requiring recharging. The battery voltage is monitored by the BATTERY meter, M103, on the front panel of the equipment.

The power supply consists of a line filter, power switch, battery, and a plug-in printed circuit board, Z200. The printed circuit board contains the bridge rectifier, charge regulator, and the voltage regulator circuits.

4.3.9.1 Input Circuits. The line filter is an "H" type low-pass filter having a cut-off frequency of 40 kHz. The line filter and the two 1/10 ampere line fuses, F301 and F302, are mounted in a shielded case. The filtered line voltage is then applied to the POWER switch, S108. In the CHARGE and ON positions, S108 connects power transformer T302 to the line through the power line selector switch, S302. This switch connects the two primary windings of T302 in parallel for 105 to 125 volts ac, and in series for 210 to 250 volts ac. The power transformer supplies a nominal 23 volts ac to the bridge rectifier, CR307 through CR310.

4.3.9.2 Charge Regulator. The rectifier dc voltage is applied to the charge regulator circuit, Q201 and Q202. Transistor Q201 is a series current regulator, and avalanche diode CR311 and resistor R314 maintain the current through Q201 at a constant 170 milliamperes. This current is unaffected by either a power line or battery voltage change. The regulated current flows through diode CR317 to the battery, and also to the shunt regulator, Q202.

integrated average voltage at (B) is not the same as the integrated rms voltage at (B), however, The ratio between the integrated rms voltage and the integrated average voltage, expressed in decibels, is the value V_d. The average voltage is always less than the rms voltage. The greater the ratio between the rms and the average, the more impulsive the noise.

4.3.8.2 F.I. Function Circuit. The F.I. function circuit is identical to the NOISE function except card Z121-2A is partially deenergized and the V_d-Battery meter indicates battery voltage.

4.3.8.3 PEAK Function Circuit. In the PEAK position, the functions are similar to those in the NOISE position with a few exceptions. The signal goes through the buffer and the log amplifiers as before. The integrating amplifier has had the time constant removed from it, however, and the output of this amplifier goes to the peak detector. Now, any signal - even a short duration impulse - that exceeds the reference level will cause a large signal on the output of the integrating amplifier (E), which is amplified by Q119 and Q120 and causes the PEAK indicator to deflect. The AGC voltage is now derived from the PEAK control, and the rms meter indicates the setting of the AGC voltage. Recall that for measurements in the NOISE position, for any CW input, the AGC voltage (and corresponding reading on the rms meter) is exactly the AGC voltage needed to make the receiver input just equal to the referenced level at the integrating amplifier. In the peak position, the AGC voltage (and its corresponding rms meter reading) is selected manually. Any input voltage exceeding the reading on the rms meter will give a voltage greater than the rms integrator reference, giving an indication on the peak indicator.

4.3.9 Power Supply

The power supply operates the EN Meter from either a single-phase ac power source of 115 or

230 volts, 50 to 400 Hz, or from an internal rechargeable battery. When an ac power source is used, the battery is normally on charge. However, the battery can be charged without turning the EN Meter on. In addition, the EN Meter can be operated from an ac power line with the battery removed. A fully-charged battery can operate the equipment for up to 40 hours before requiring recharging. The battery voltage is monitored by the BATTERY meter, M103, on the front panel of the equipment.

The power supply consists of a line filter, power switch, battery, and a plug-in printed circuit board, Z200. The printed circuit board contains the bridge rectifier, charge regulator, and the voltage regulator circuits.

4.3.9.1 Input Circuits. The line filter is an "H" type low-pass filter having a cut-off frequency of 40 kHz. The line filter and the two 1/10 ampere line fuses, F301 and F302, are mounted in a shielded case. The filtered line voltage is then applied to the POWER switch, S108. In the CHARGE and ON positions, S108 connects power transformer T302 to the line through the power line selector switch, S302. This switch connects the two primary windings of T302 in parallel for 105 to 125 volts ac, and in series for 210 to 250 volts ac. The power transformer supplies a nominal 23 volts ac to the bridge rectifier, CR307 through CR310.

4.3.9.2 Charge Regulator. The rectifier dc voltage is applied to the charge regulator circuit, Q201 and Q202. Transistor Q201 is a series current regulator, and avalanche diode CR311 and resistor R314 maintain the current through Q201 at a constant 170 milliamperes. This current is unaffected by either a power line or battery voltage change. The regulated current flows through diode CR317 to the battery, and also to the shunt regulator, Q202.

Diode CR317 prevents the battery from discharging back through the charging circuits. When the battery is fully charged its output is 17 volts, and only a trickle charge current of 40 to 60 milliamperes flows. The rest of the current is routed to Q202. Potentiometer R318 provides a trickle charge current adjustment.

4.3.9.3 Voltage Regulator. The battery voltage rises from 14 to 17 volts during charge, and drops from 17 to 14 volts during discharge. In either case the battery output voltage is regulated at 12 volts ±0.1 by a series voltage regulator, Q203 and Q204. The control element is Q203, and avalanche diode CR314 is the reference element, while Q204 functions as the comparator. Stabistors CR315 and CR316 provide temperature stability, and potentiometer R324 provides a fine adjustment for the regulated output voltage. The V_d-BATTERY meter, M103, is connected between the battery and the regulated 12 volts in the F.I. and BFO positions of the FUNCTION switch and therefore monitors the battery voltage above 12 volts.

When the POWER switch, S108, is set to the ON position, S108D, connects the regulated +12 volts dc to the EN Meter. The battery charge current is then reduced by the current drain of the EN Meter and the battery charging time is correspondingly longer.

In the CHARGE position of S108, the EN Meter is disconnected from the regulated 12 volts. However, the 12 volts regulator is still "ON", and serves as the reference voltage for the V_d-BATTERY meter.

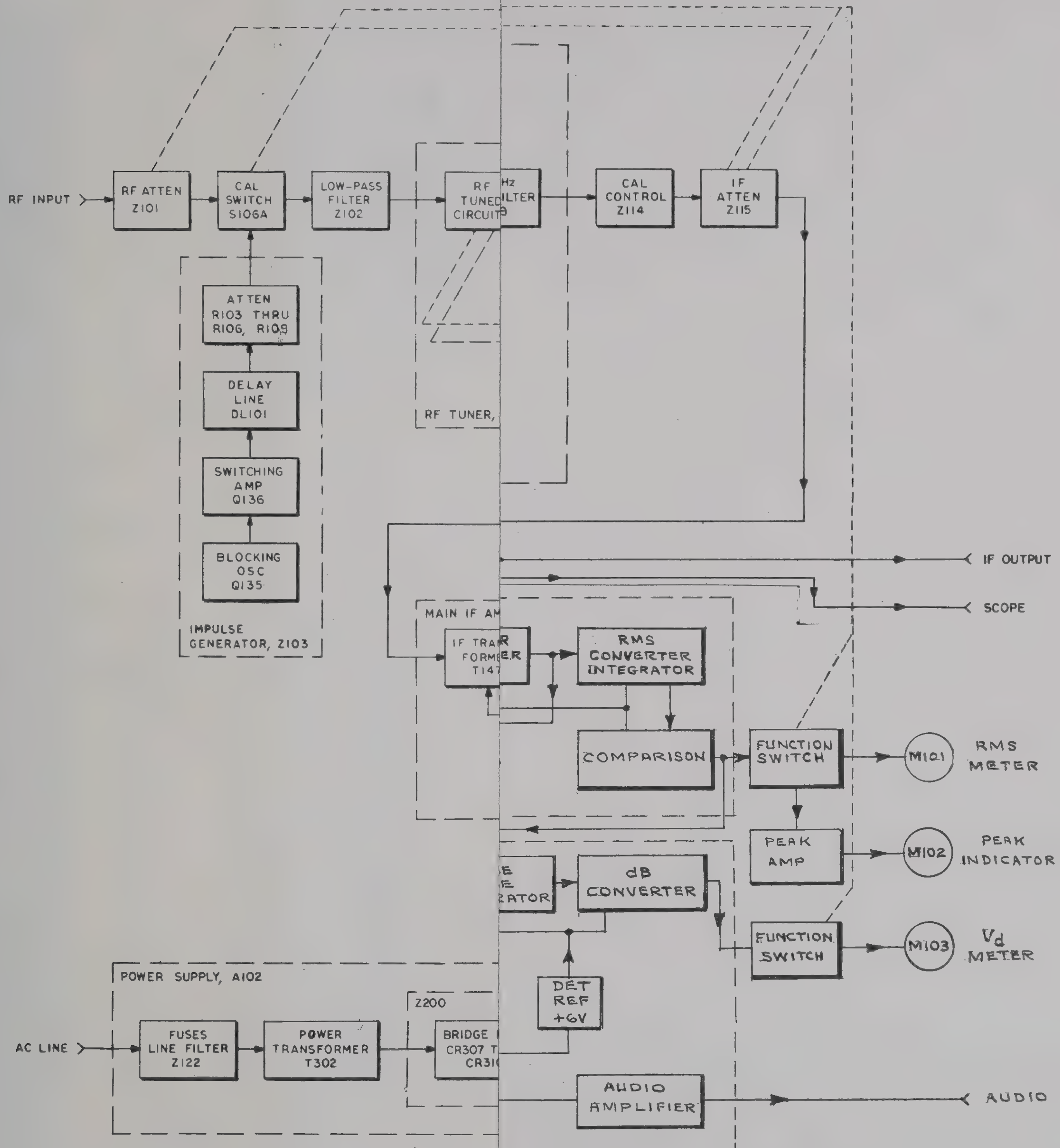


Figure 4-1. NM-26T EN Meter, Functional Block Diagram

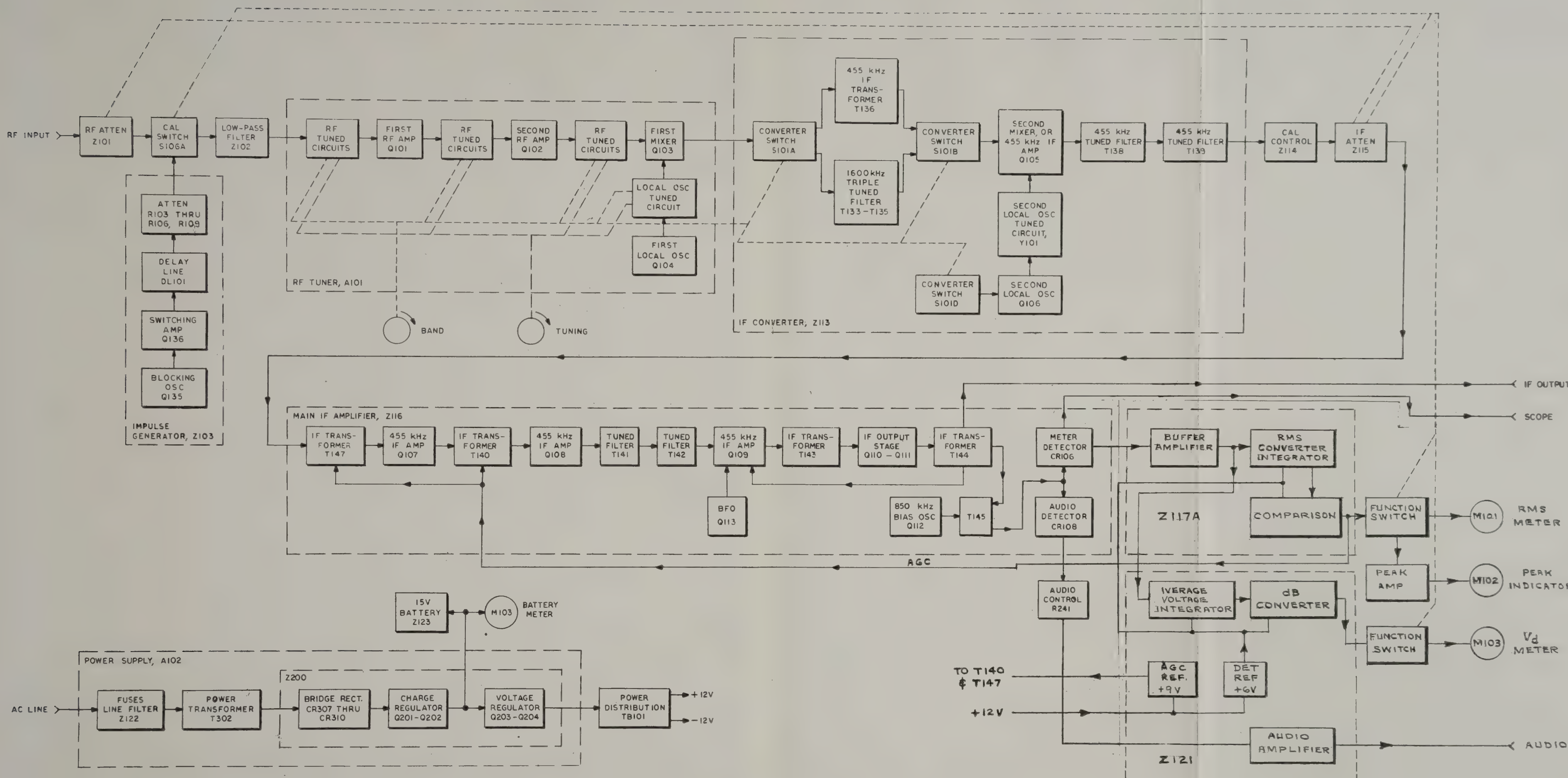


Figure 4-1. NM-26T EN Meter, Functional Block Diagram

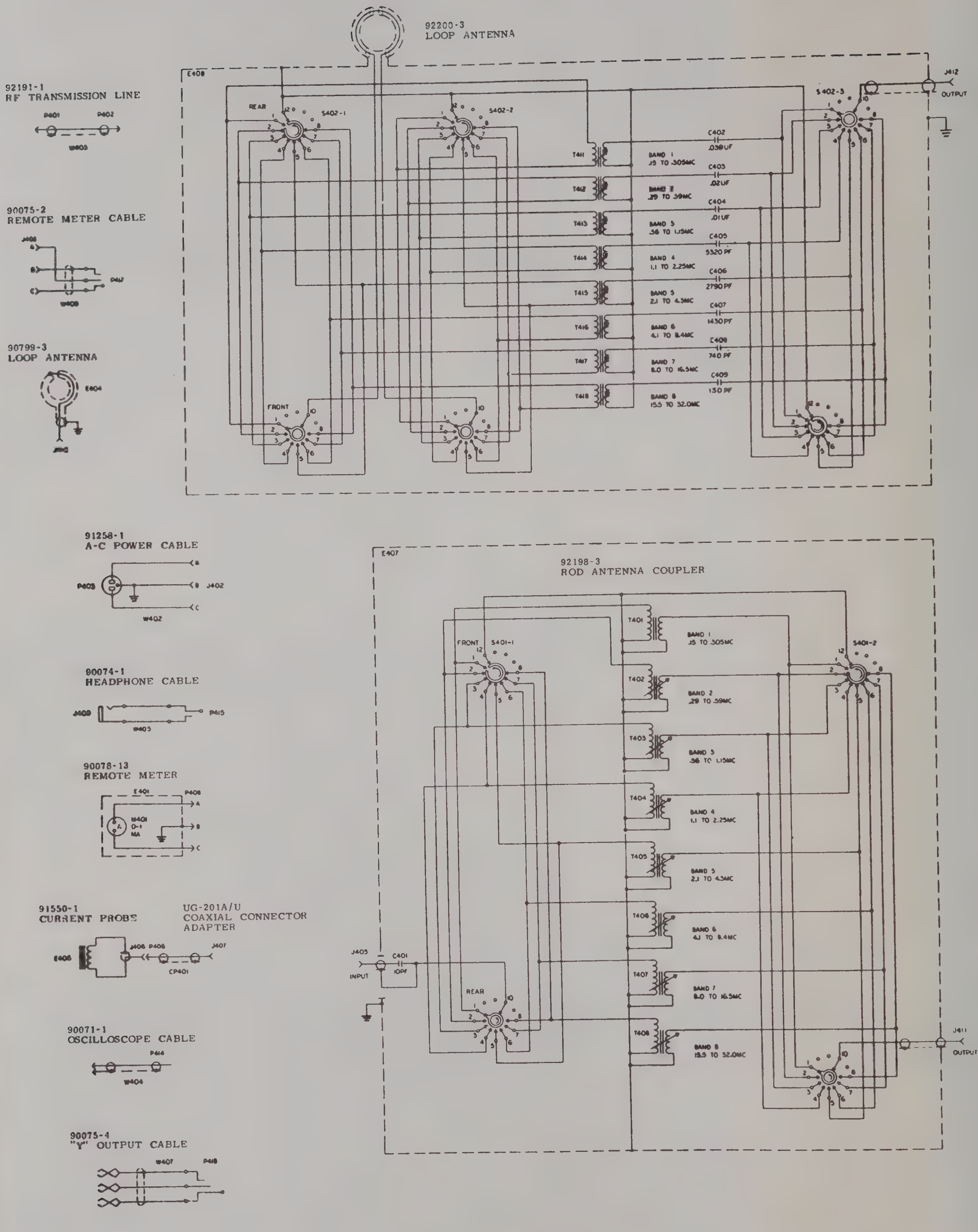


Figure 4-2. NM-26T EN Meter Accessories, Schematic Diagram

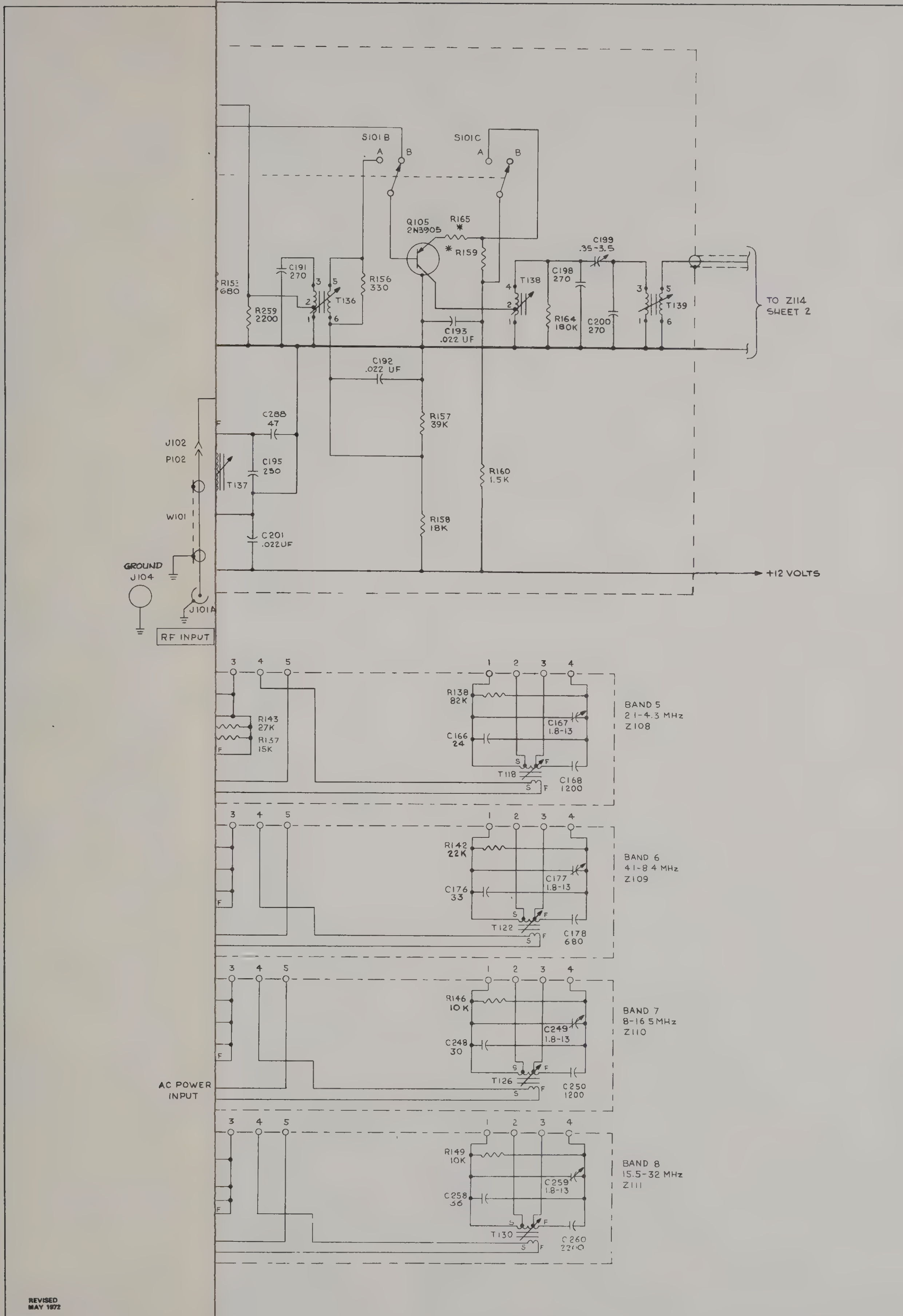


Figure 4-3. NM-26T EN Meter, Schematic Diagram (Sheet 1 of 2)

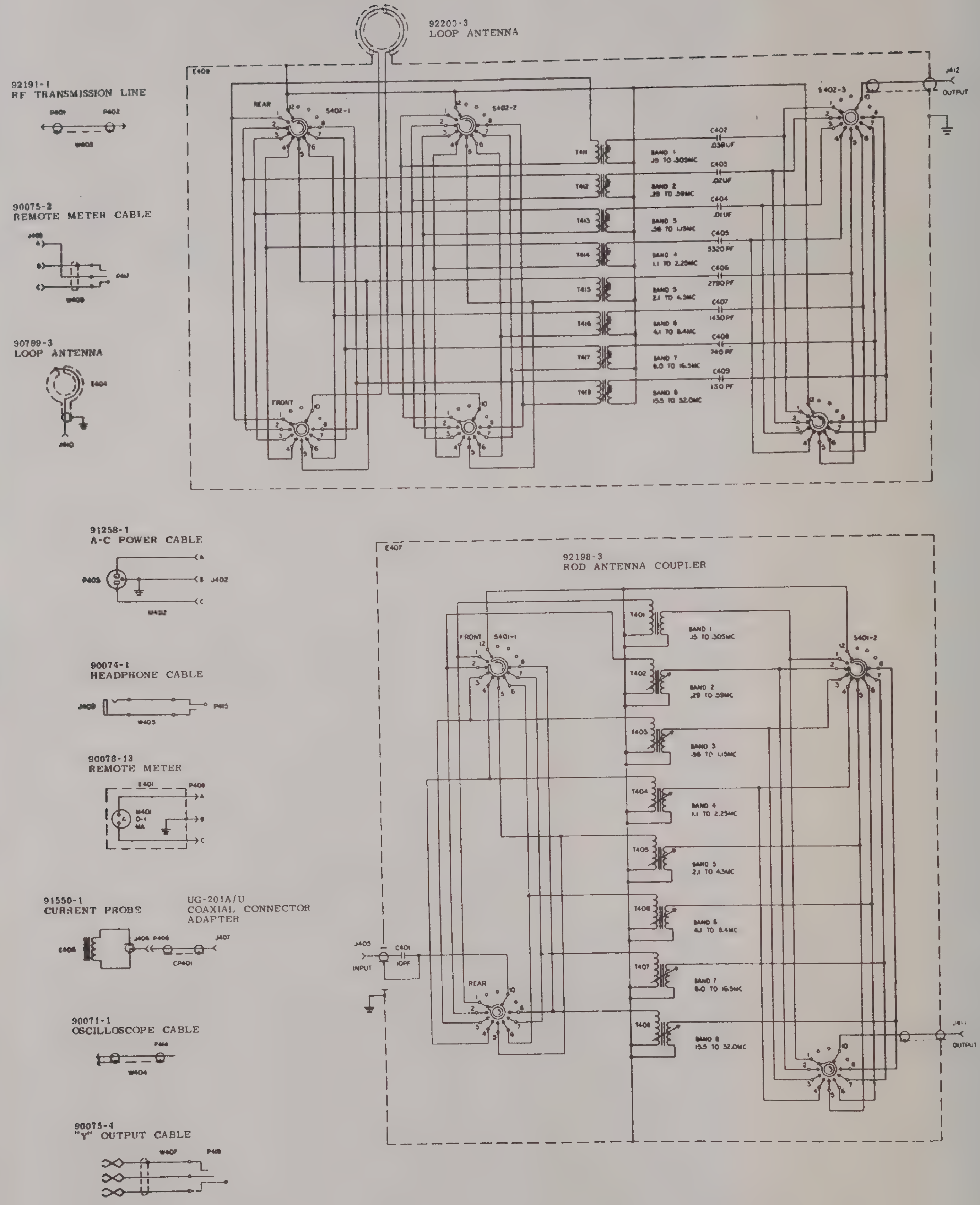


Figure 4-2. NM-26T EN Meter Accessories, Schematic Diagram

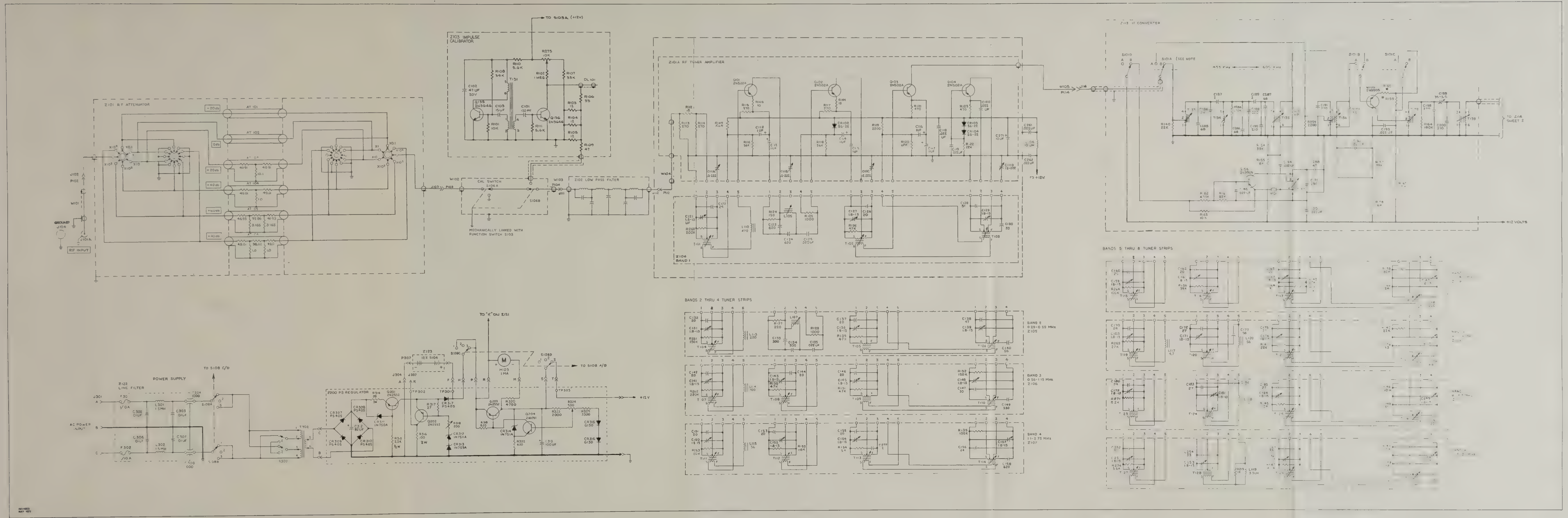


Figure 4-3. NM-26T EN Meter, Schematic Diagram (Sheet 1 of 2)

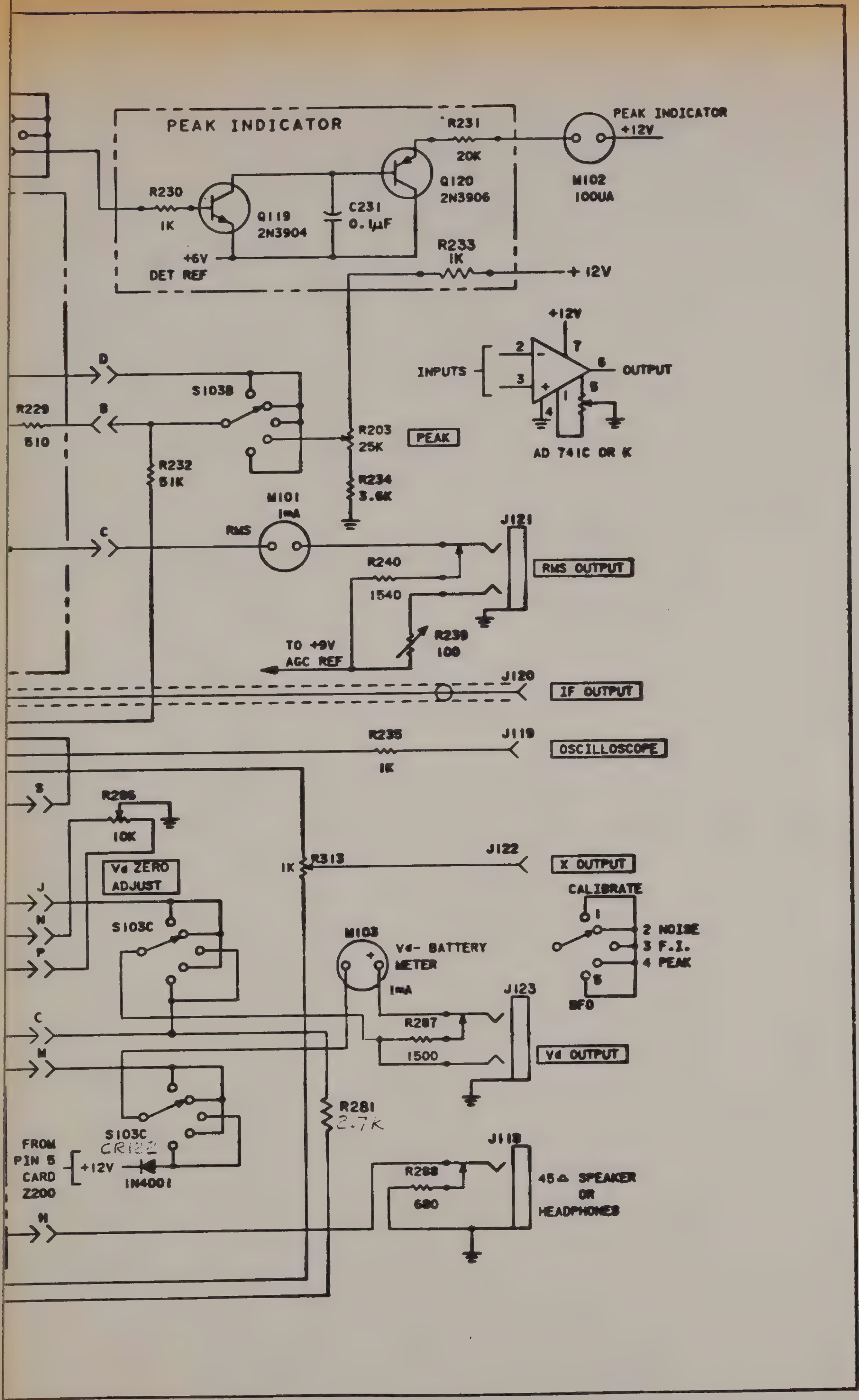
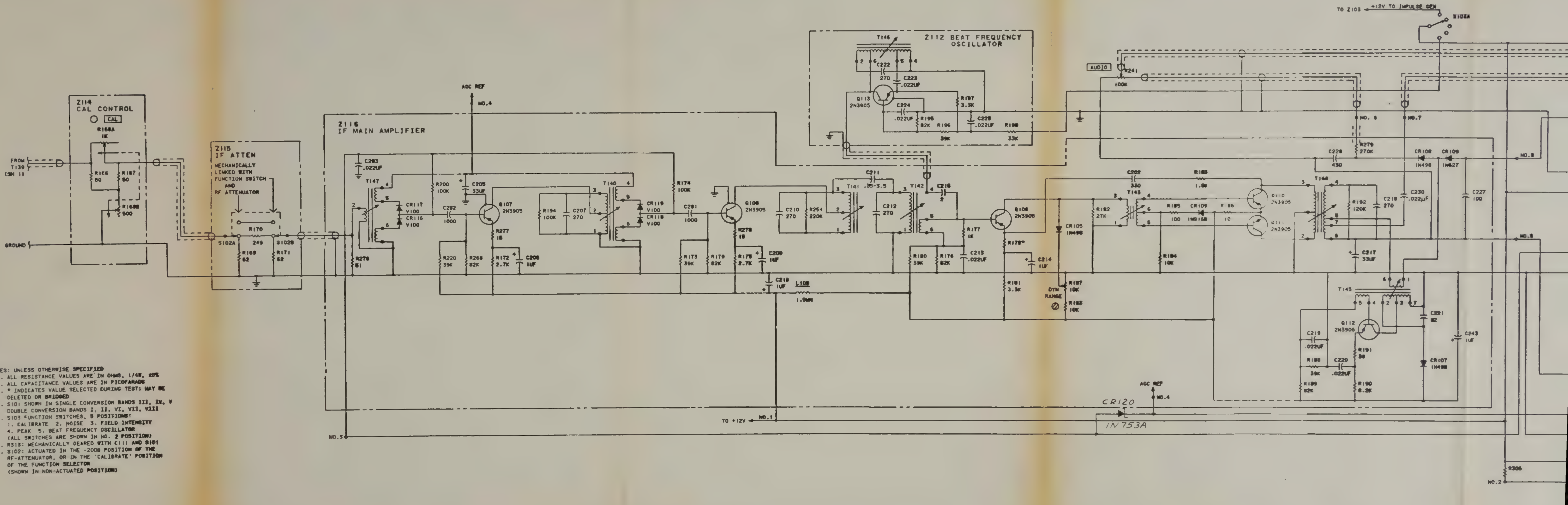


Figure 4-3. NM-26T EN Meter, Schematic Diagram (Sheet 2 of 2)



NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTANCE VALUES ARE IN OHMS, 1/4W, ±5%
2. ALL CAPACITANCE VALUES ARE IN PICOFARADS
3. * INDICATES VALUE SELECTED DURING TEST; MAY BE DELETED OR BRIDGED
4. S101 SHOWN IN SINGLE CONVERSION BANDS III, IV, V DOUBLE CONVERSION BANDS I, II, VI, VII, VIII
5. S103 FUNCTION SWITCHES, 5 POSITIONS:
   1. CALIBRATE 2. NOISE 3. FIELD INTENSITY
   4. PEAK 5. BEAT FREQUENCY OSCILLATOR
   (ALL SWITCHES ARE SHOWN IN NO. 2 POSITION)
6. R313: MECHANICALLY GEARED WITH C111 AND S101
7. S102: ACTUATED IN THE -20DB POSITION OF THE RF-ATTENUATOR, OR IN THE 'CALIBRATE' POSITION OF THE FUNCTION SELECTOR
   (SHOWN IN NON-ACTUATED POSITION)

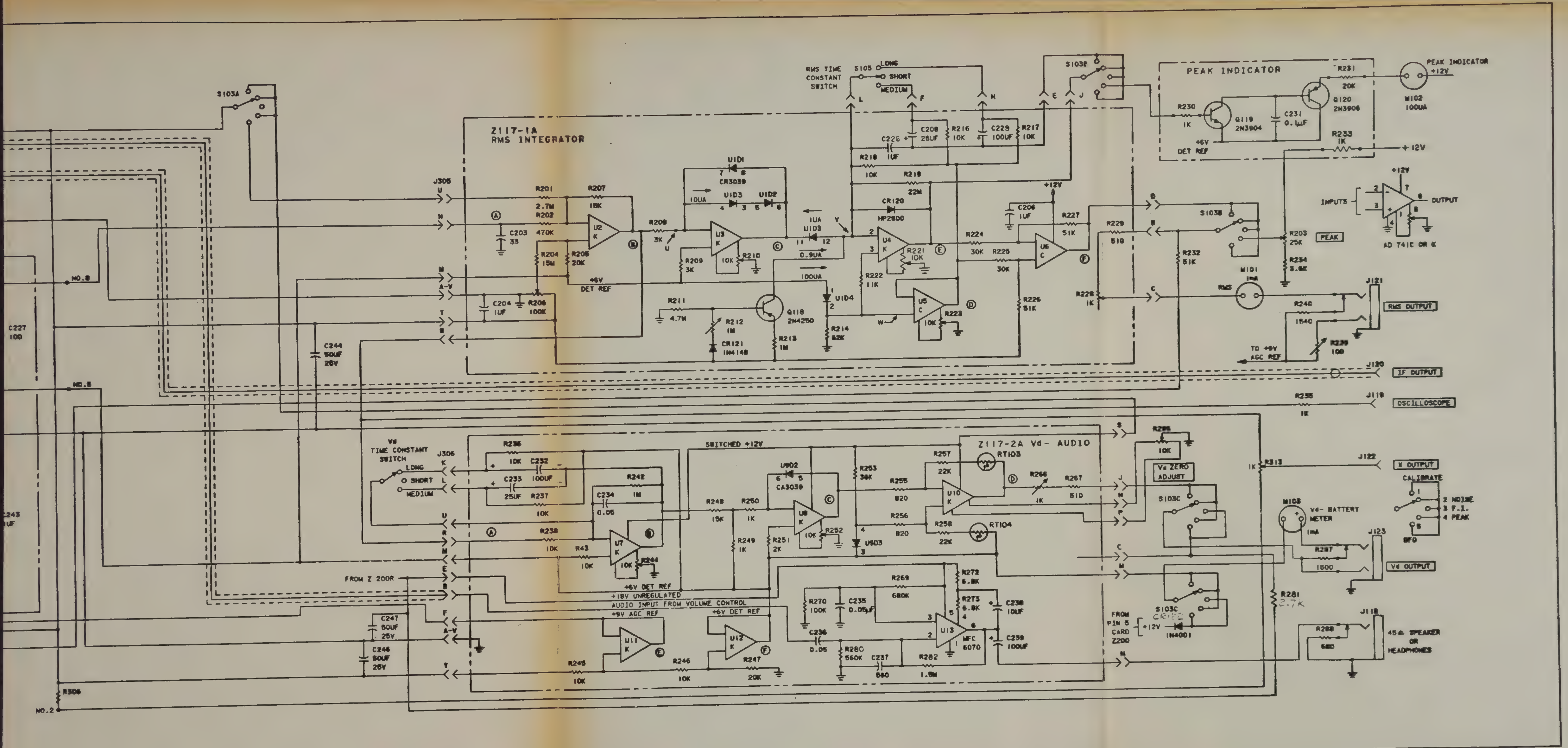


Figure 4-3. NM-26T EN Meter, Schematic Diagram (Sheet 2 of 2)

Section V

MAINTENANCE

5.1 INTRODUCTION

This Section contains general maintenance information, troubleshooting procedures, alignment and adjustment instructions, and recommended servicing procedures for the solid-state circuitry and printed circuit boards.

5.2 GENERAL MAINTENANCE INFORMATION

5.2.1 Basic Requirements

Each NM-26T EN Meter is carefully checked following alignment and calibration at the factory, and no further internal adjustments are required prior to placing the equipment in operation. In the event of a failure or malfunction, troubleshooting or adjustments should be attempted only if proper test equipment is available, and only by technicians experienced in the maintenance and calibration of EN Meters.

5.2.2 Test Equipment Required for Maintenance

The test equipment required for troubleshooting, alignment, and/or calibration is tabulated in Table 5-1.

Table 5-1. Test Equipment Required for Maintenance

Description	Recommended Type	Use
DC VTVM	Hewlett-Packard, Model 410B	Transistor dc voltage measurement and power supply adjustment
Digital Voltmeter	Fluke, Model 8000A	Alignment of Z117-1A and Z121-2A P.C. cards.
RF VTVM	Ballantine, Model 314	RF and IF alignment
RF Signal Generator	General Radio, Model 1001A	RF and IF alignment and meter scale tracking adjustments
Frequency Counter	Hewlett-Packard, Model 524/525A	RF and IF alignment
Tunable RF VTVM	Singer Model NM-22A or NM-25T	RF alignment

5.2.3 Removal of EN Meter from Case

The EN Meter is secured to the case by eight screws in the front panel. To remove the unit from the case, loosen these screws and lift out by the carrying handles on the front panel.

WARNING

Do not remove the EN Meter from the case when the power cable is attached to the ac line, or if the POWER switch is in the CHARGE or ON position.

5.2.4 Power Requirements for Alignment

All alignment and meter scale tracking adjustments are made with the internal power supply regulator output voltage at 12 volts, ±0.1. If deviations are noted in tuning dial calibration or meter scale tracking, or if the gain standardization adjustment is difficult, check the power supply output voltage before attempting to align or adjust the EN Meter.

5.3 ISOLATING MALFUNCTIONS

5.3.1 Basic Troubleshooting Philosophy

Most malfunctions in an EN Meter can be located by considering the unit as a conventional communications receiver having a built-in electronic voltmeter. Inspect the equipment carefully and try to isolate the malfunction visually. Check that the operating controls are properly set, as described in Section III. If one of the signal pickup devices is suspected as the source of trouble, check circuit continuity through the device. If the malfunction is established as in the EN Meter, isolate the trouble to a particular section, then to the defective stage.

5.3.2 Troubleshooting

The Troubleshooting Chart, Table 5-2, will aid in isolating the fault to a particular section of the EN Meter. Once this has been accomplished, check the transistor element voltages, as tabulated in Table 5-3, and the integrated circuit element voltages, as tabulated in Table 5-4. A significant difference in one or more of these voltages should be considered cause for component checks in that stage.

Table 5-2. Troubleshooting Chart

Malfunction	Possible Reason	Procedure
During the charge or operation from the power line, the battery meter fails to read in the white section.	(a) Power line voltage is not connected to the power transformer. (b) Battery charger is defective. (c) Battery is defective.	(1) Check the power line voltage. (2) Check Fuses F301 and F302. (3) Check switches S108 and S302. (4) Check dc voltages on Q201, Q202. (5) Check the battery cells.

Table 5-2. Troubleshooting Chart (Continued)

Malfunction	Possible Reason	Procedure
Operation time of the fully charged battery is short.	Battery is defective.	(1) Check battery cells.
Battery charge time is too long	Battery charger improperly adjusted.	(1) Readjust battery charger according to para. 5.7.2.
With FUNCTION switch in CAL position, no meter indication, but signal is audible in the headphone.	Metering circuit defective.	(1) Check voltages on the Z117-1A PC card.
Meter indicates, but signal is not audible in headphone.	Audio amplifier is defective.	(1) Check dc voltages on U13.
Visual peak indicator is not working.	Peak indicator circuit defective.	(1) Check dc voltages on Q119 and Q120.
V_d meter not indicating in the V_d function.	V_d circuit defective.	Check voltages on the Z121-2A PC card.
Receiver is not working in one band.	(a) RF strip is defective (b) Bandswitch is not contacting.	(1) Check the particular RF strip. (2) Check the turret contacts.
Receiver is not working in single conversion band, or in a double conversion band.	(a) IF converter switch is not contacting. (b) Second LO stage is defective.	(1) Check converter switch. (2) Check the dc voltages on Q106.
Receiver is not working in any band.	(a) RF amplifier defective. (b) IF converter is defective. (c) IF main amplifier is defective.	(1) Check dc voltage on Q101-104. (2) Check dc voltage on Q105. (3) Check dc voltage on Q107 to Q111.

Table 5-3. Transistor Voltages

Stage	Function	Type	V^v_E	V^v_B	V^v_C	Notes
Q101	1st RF Amplifier	2N502A	11.3	11.0	0	
Q102	2nd RF Amplifier	2N502A	11.3	11.0	0	
Q103	1st Mixer	2N502A	11.4	11.3	0	
Q104	1st Local Oscillator	2N502A	10.4	10.6	0	
Q105	IF Converter Preamplifier	2N3905	9.1	8.5	0	For single conversion
Q106	2nd Local Oscillator	2N3905	3.1+	2.7+	0+	For double conversion
Q107	IF Main Amplifier, 1st Stage	2N3905	9.1	8.2	0	With no signal
Q108	IF Main Amplifier, 2nd Stage	2N3905	9.1	8.4	0	With no signal
Q109	IF Main Amplifier, Driver Stage	2N3905	9.0	8.3	0	
Q110	IF Main Amplifier, Output Stage	2N3905	11.7	11.1	0	With no signal
Q111	IF Main Amplifier, Output Stage	2N3905	11.7	11.1	0	With no signal
Q112	Bias Oscillator	2N3905	4.7	4.1	0	
Q113	Beat Frequency Oscillator	2N3905	3.3	2.7	0	FUNCTION switch in BFO
Q118	Current Source	2N4250	10.86	10.0	5.33	FUNCTION switch in NOISE
Q119	Peak Indicator, 1st Stage	2N3904	6.0	5.18	9.22	FUNCTION switch in PEAK
Q120	Peak Indicator, 2nd Stage	2N3906	12.0	9.22	6.0	FUNCTION switch in PEAK
Q135	Impulse Generator	2N3646	0	-1.1	7.5	FUNCTION switch in CAL position
Q136	Impulse Generator	2N3646	0	0	9.1	FUNCTION switch in CAL position

+Tune T137 for minimum voltage at emitter.

Table 5-3. Transistor Voltages (Continued)

Stage	Function	Type	V^{V}_{E}	V^{V}_{B}	V^{V}_{C}	Notes
Q201	Charge Regulator	2N2552	19.0	19.2	17.6*	Power line voltage 115 V
Q202	Charge Regulator	2N2552	17.6*	17.2*	7.7	
Q203	Voltage Regulator	2N2552	16.9*	7.4*	12.0	
Q204	Voltage Regulator	2N1711	7.3	7.8	7.4*	

*Battery fully charged, power switch ON.

NOTE: Use a digital voltmeter for all transistor voltage measurements. Voltages are measured from chassis ground.

Table 5-4. Integrated Circuit Voltages (Typical)

Use digital voltmeter with floating reference input and at least 10 megohms input impedance for all IC voltage measurements. Voltages are measured from the +6V DET REF circuit unless otherwise noted. FUNCTION switch in NOISE position. Zero input signal and ATTENUATOR in X10 position.

	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	U11	U12	U13*
Pin 1:	-6.0	0	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0	0	-6.0	-6.0	-6.0	0
Pin 2:	0	-0.67	0	-0.67	-0.67	+1.47	0	-0.05	0	+0.64	+3.06	0	+2.32
Pin 3:	0	-0.59	0	-0.67	-0.67	+1.82	0	0	0	+0.65	+3.06	0	+2.37
Pin 4:	-6.0	0	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0	+0.67	-6.0	-6.0	-6.0	+10.12
Pin 5:	-6.0	-0.59	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0	+0.65	-6.0	-6.0	-6.0	+16.6
Pin 6:	+0.015	-1.18	-1.18	-0.80	-0.67	+5.33	-1.67	+0.65	-0.01	+0.45	+3.06	0	+8.89
Pin 7:	+6.0	0	+6.0	+6.0	+6.0	+6.0	+6.0	+6.0	0	+6.0	+6.0	+6.0	---
Pin 8:	+6.0	-1.18	+6.0	0	0	0	+6.0	+6.0	0	+6.0	+6.0	+6.0	---
Pin 11:	---	-1.18	---	---	---	---	---	---	0	---	---	---	---
Pin 12:	---	-6.7	---	---	---	---	---	---	0	---	---	---	---

* Measure voltages from chassis ground.

5.4 ALIGNMENT AND ADJUSTMENT

5.4.1 Alignment of IF Section and Dynamic Range Adjustment

The IF amplifier must be correctly aligned before any other adjustments can be made. Alignment of the IF stages directly affects the meter scale tracking adjustments, and the RF tuner alignment.

5.4.1.1 Alignment of Main IF Amplifier, Z116. The main IF amplifier alignment procedure is as follows:

a. Remove the EN Meter from the case, as described in paragraph 5.2.3.

b. Remove the shield plate from the IF amplifier.

c. Set the operating controls as follows:

POWER switch	To ON position
FUNCTION switch	To NOISE position
ATTENUATOR switch	To 0 dB position
TUNING control	To any position
CAL control	Full clockwise
AUDIO control	Full counterclockwise
BAND switch	To any position

d. Connect the input terminals of a Frequency Counter to the output terminals of a VTVM, and place the VTVM probe within 1/2 inch of the bias oscillator, Q112 (radiation from this oscillator is sufficient for adequate electrostatic pickup by the probe).

e. Note the frequency of the bias oscillator indicated on the Frequency Counter. The frequency should be between 835 and 865 kHz. If not, adjust the slug in T145 as required, using an insulated tuning tool.

f. Locate terminals "A" and "B" on the bottom of printed circuit board Z116. Disconnect capacitor C202 from one of the terminals, opening the negative feedback loop between the IF output and driver stages.

g. Rotate the "dynamic range" potentiometer, R187, fully counterclockwise. (This is the only potentiometer on board Z116.)

h. Connect the Frequency Counter to the high level output of an RF Signal Generator. Adjust the signal generator frequency to exactly 455 kHz, and connect the adjustable output level to pins 1 and 3 of T142. (Pin 1 is ground.)

i. Adjust the Signal Generator output level to produce an "on-scale" reading on the front panel meter.

j. Using the insulated tuning tool, adjust the slug in T144 to obtain maximum indication on the front meter. Monitor the signal generator frequency on the counter, maintaining it at 455 kHz (reduce the signal generator output level as necessary to maintain an "on-scale" reading on the meter).

k. Reconnect capacitor C202 (step "f") and connect the signal generator output to the wiper or the CAL potentiometer, R168A.

l. Adjust the Signal Generator output level to produce an "on-scale" reading on the front panel meter.

m. Using the insulated tuning tool, adjust the slugs in T140 through T142 to obtain maximum indication on the rms meter. Monitor the signal generator frequency on the counter, maintaining it at 455 kHz. (Adjust the signal generator output level as necessary to maintain an "on-scale" reading on the meter.)

NOTE:

A "full-scale" panel meter reading will be obtained with approximately 300 to 400 microvolts input.

5.4.1.2 Alignment of the IF Converter, Z113. Align the IF converter as follows:

a. With the Ballantine VTVM connected to the IF OUTPUT receptacle, J120, connect the Frequency Counter to the output of the VTVM.

b. Connect the Signal Generator output to the RF INPUT receptacle of the EN Meter.

c. Set the EN Meter BAND switch to the BAND 3 position and tune the signal generator to any frequency within this band.

d. Tune the EN Meter to the signal generator frequency, carefully adjusting the TUNING control until an indication of exactly 455 kHz is noted on the Frequency Counter.

e. Adjust the slug in T139 for maximum output on the VTVM, continually monitoring the output on the counter to maintain a frequency of 455 kHz. (Reduce the signal generator output level as necessary to maintain an "on-scale" reading on the meter.)

f. Adjust the slug in T138 to obtain maximum output on the VTVM. Alternately repeak T139 and T138.

g. Adjust the slug in T136 to obtain maximum output on the VTVM.

h. Set the EN Meter BAND switch to the BAND 1 position and disconnect the VTVM and counter from the IF OUTPUT receptacle.

i. Position the VTVM probe within 1/2 inch of the second local oscillator, Q106. (Radiation from this oscillator is sufficient for adequate electrostatic pickup by the probe.)

j. The second local oscillator frequency must be exactly 2055 kHz, indicated on the counter. If necessary, adjust the slug in T137 to obtain this frequency.

k. Reconnect the VTVM and counter to the IF OUTPUT receptacle, and tune the signal generator to any frequency in Band 1.

l. Tune the EN Meter to the signal generator frequency, carefully adjusting the TUNING control until an indication of exactly 455 kHz is noted on the Frequency Counter.

m. Adjust the slugs in T133 through T135 for maximum output on the VTVM.

5.4.2 Alignment of the RF Tuner

The RF tuner has been carefully aligned at the factory for optimum performance. Although the alignment procedures are conventional, they must be performed correctly. Do not attempt RF realignment unless absolutely necessary.

5.4.2.1 Necessity for Realignment. Replacing certain critical RF tuner components may necessitate realignment of the tuner. To determine whether or not the tuner requires realignment, proceed as follows:

a. Set the equipment up in a normal operating configuration, as described in paragraph 2.4.3.

b. Set the FUNCTION switch to the CAL position, and adjust the CAL control to obtain a convenient indication on the front panel meter.

c. Carefully tune the EN Meter from the low to the high end of each band, noting the response on the panel meter.

d. If the response in step "c" differs by more than 10 dB within a particular band, realignment of that band is indicated.

5.4.2.2 Realignment Procedure. The RF tuner realignment procedure for any particular band is as follows:

a. Remove the EN Meter from the case, as described in paragraph 5.2.3.

b. Remove the cover to the RF tuner assembly.

c. Connect a headset to the front panel AUDIO receptacle.

d. Set the operating controls as follows:

POWER switch	To ON position
FUNCTION switch	To FI position
ATTENUATOR switch	To 0 dB position
TUNING control	As called for
CAL control	Full clockwise
AUDIO control	For comfortable headset level
BAND switch	To desired band

e. Connect the 50 ohm output of the Signal Generator to the RF INPUT receptacle of the EN Meter.

f. Tune the EN Meter and Signal Generator to exactly the same frequency at the low end of the band to be aligned. Adjust the Signal Generator for a 30 percent modulated output signal.

g. The turret tuner strip corresponding to the selected band, and the transformers and capacitors to be adjusted are tabulated in Table 5-5. Also, refer to Figure 5-1 for the physical location of the various adjustment points on the turret tuner strip.

Table 5-5. RF Tuner Adjustment Points

BAND	TURRET STRIP	1st RF AMPLIFIER TRANS	1st RF AMPLIFIER CAP	2nd RF AMPLIFIER TRANS	2nd RF AMPLIFIER CAP	MIXER TRANS	MIXER CAP	1st LOCAL OSCILLATOR TRANS	1st LOCAL OSCILLATOR CAP
1	Z104	T101	C121	L105*	--	T102	C127	T103	C129
2	Z105	T104	C131	L107*	--	T105	C136	T106	C139
3	Z106	T107	C141	T108	C143	T109	C145	T110	C148
4	Z107	T111	C150	T112	C152	T113	C154	T114	C157
5	Z108	T115	C159	T116	C161	T117	C163	T118	C167
6	Z109	T119	C169	T120	C171	T121	C174	T122	C177
7	Z110	T123	C179	T124	C181	T125	C184	T126	C249
8	Z111	T127	C251	T128	C253	T129	C256	T130	C259

* Not to be adjusted

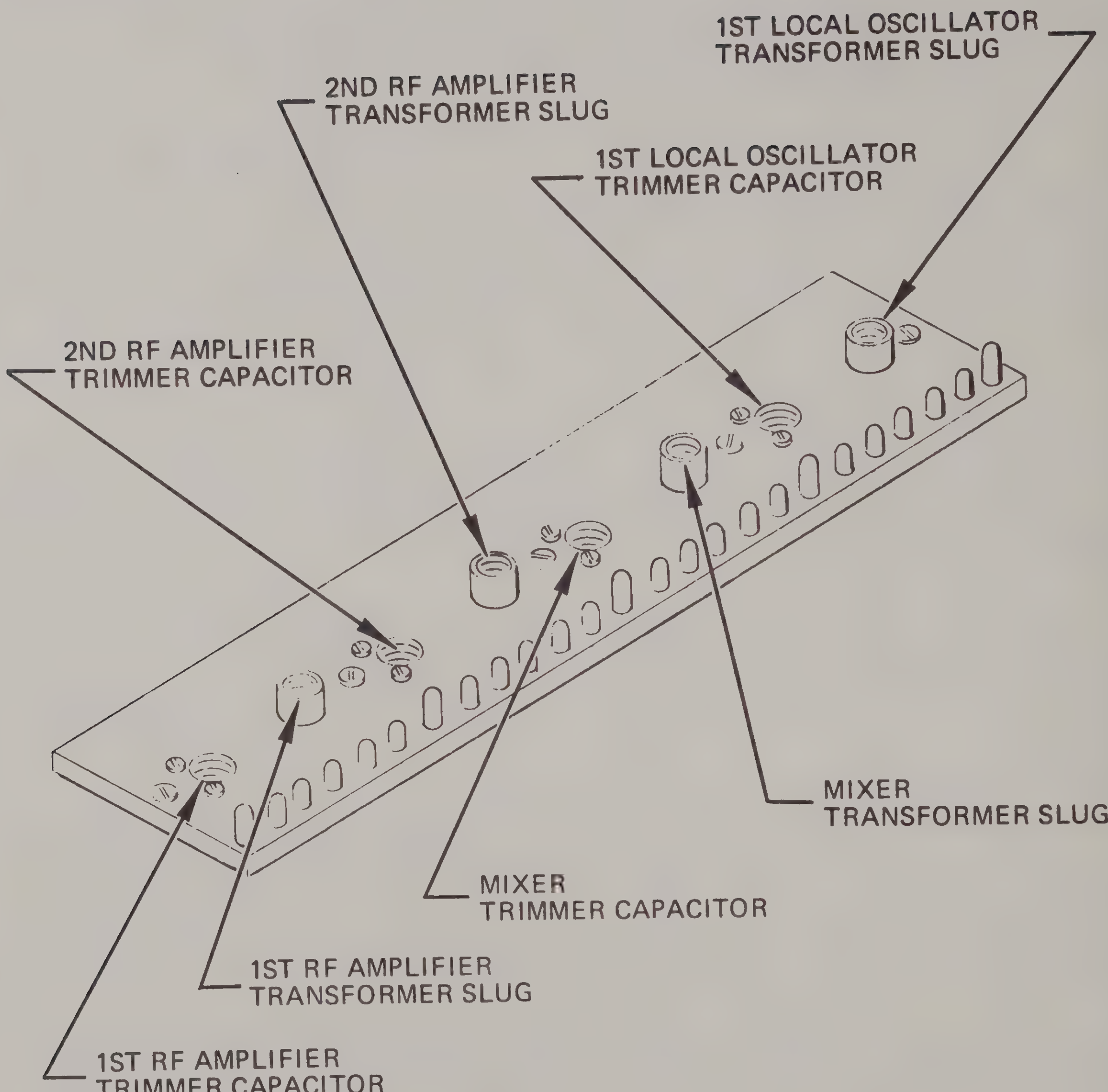


Figure 5-1. Location of RF Tuner Adjustments

h. Using an insulated tuning tool, adjust the slug in the first local oscillator transformer to obtain maximum response on the front panel meter.

NOTE:

The Signal Generator tone modulation should now be audible in the headset.

i. Repeat step "f" at the high end of the band being aligned.

j. Using an insulated tuning tool, adjust the first local oscillator trimmer capacitor to obtain maximum response on the front panel meter.

k. Alternately repeat steps "f" through "j" until no further "peaking" is possible.

NOTE:

The final adjustment in step "k" should be at the high end of the band.

l. Repeat step "f" at low end of band being aligned.

m. Using an insulated tuning tool, adjust the slug in the first RF amplifier transformer to obtain maximum response on the front panel meter.

CAUTION

On Bands 1 and 2, the first interstage coupling consists of a low-pass filter. The slugs in L105 and L107 <u>should</u> <u>not</u> be adjusted during alignment.

n. Repeat step "f" at the high end of the band being aligned.

o. Using an insulated tuning tool, adjust the first RF amplifier trimmer capacitor to obtain maximum response on the front panel meter.

p. Alternately repeat steps "l" through "o" until no further "peaking" is possible, with the final adjustment at the high end of the band.

q. Repeat steps "l" through "p" for the second RF amplifier and mixer stages until no further "peaking" is possible.

5.4.3 RMS and V_d Circuit Alignment

5.4.3.1 Initial Procedures.

1. Set the CAL control for 3/4 range clockwise. Adjust the Dynamic Range potentiometer, R187, for maximum range. Energize the EN Meter, turn the FUNCTION switch to the FI position, and read the battery voltage on the V_d-BATTERY meter. If the battery voltage does not read within the operating range, check the unregulated +18 V and the regulated +12 V to see whether the battery meter is reading the proper voltages. If everything seems okay except that the battery voltage is low, switch the power switch to CHARGE. If CHARGE give appreciably different readings from ON, there probably is excessive current drain in the receiver which must be found and corrected before proceeding. If CHARGE also gives the same low reading as ON, leave the switch on CHARGE until the battery voltage comes into the operating range. Then turn to ON and proceed with the calibration procedure.

2. Plug in speaker and check to see that the audio amplifier works. You should be able to hear the impulse generator through the speaker when in the CALIBRATE position of the function switch and possibly set noise in the other positions of the switch. Any whistling is a sign of oscillation somewhere in the receiver and probably means that some other problems need to be corrected before proceeding further. It will be helpful to leave the speaker plugged and turned on with low volume throughout the calibration procedure, as it may help to detect various modes of misbehavior. If the speaker is turned up too far, however, it may draw excessive current from the power supply and cause motorboating or other types of blocking oscillation.

3. Turn function switch to FI position. Connect an RF generator through an attenuator with several 10 dB steps to the RF input. Set the receiver input attenuator to the +20 dB or

higher input attenuator position. Tune the receiver and generator to some convenient frequency. Tune the receiver to the generator and adjust signal for a mid-scale reading on the rms meter. If the meter reading is off scale and if the audio amplifier indicates an oscillation, etc., the unit must be adjusted until it performs in a nicer manner. It may help to adjust the potentiometers on the rms integrator card. Check the +6 V reference and the +9 AGC reference voltage, which should be within 0.3 V of their nominal voltage.

5.4.3.2 Adjustments of rms Integrator Card

1. Put rms integrator card (Z117-1A) on an extension so that voltages may be measured and adjustments made. Connect the reference input of the DVM to the +6 V reference line. (CAUTION: The DVM must have a floating reference input. If the +6 V is shorted to ground because DVM does not have a floating reference, damage may result to the rms integrator card.)

2. Turn the function switch to the PEAK position, adjust the PEAK pot for maximum rms meter reading, increase input attenuation, and decrease input signal. These measures will insure essentially zero input to the IF amplifier detector. Adjust R206 to give an output at (B) of +1.3 mV. This adjustment balances out the voltage injected into the detector by the bias oscillator circuit associated with Q112 just enough to give the detector maximum dynamic range. A more sensitive adjustment is made later on the V_d audio card, but this adjustment is sufficient to ensure good operation of the rms converters.

3. Turn the function switch back to the FI position. Adjust the input signal to give a mid-scale reading on the rms meter. The ATTENUATOR control should be left at the +20 dB position, in general, so that internal set noise does not affect the readings. Adjust R210 until

point U is within 0.1 mV of the +6 V reference. Measure the voltage at point W; it should be about -.665 V. Adjust R220 to give exactly (within 0.2 mV) the same voltage at point V as the voltage at W. Adjust R223 to give exactly the same voltage at (D). Adjust R212 to give 30 mV at (B). During all of the immediately preceding steps, the meter must be kept on scale. It is important for this adjustment procedure to work that the AGC control loop be kept operating and responding to the input signal in a more or less normal way. This means that it may be necessary to change the input signal to keep the rms meter reading on scale. In the event that this does not suffice to keep the reading on scale, you can adjust any, or all, of the pots R206 through R223 that have not already been finally adjusted.

4. Adjust R228 so that a 40 dB change of input signal gives a 40 dB change of meter reading. One should watch for the meter needle sticking slightly or giving different readings going up or coming down.

5.4.3.3 V_d-Audio Card Adjustment

1. Remove the rms integrator card from the extender and plug into the chassis. Put the V_d-Audio card on an extender. Turn the function switch to the NOISE position and put in enough signal to make the rms meter read mid-scale.

2. With the DVM reference input connected to the +6 V reference, adjust R244 until (A) is within 1.0 mV of the +6 V ref. Now switch into the medium or long time constants and adjust R244 until the voltage at (B) does not change when switching between long and short time constants. Do not again adjust R244 for other alignment purposes.

3. Turn the function switch to the PEAK position and adjust the input signal until the V_d meter reads 0 dB. Decrease the input signal 10 dB and 20 dB, noting where the meter reads. Adjust R252 and R266 until the V_d meter reads correctly on 0, 10, and 20 dB. R252 is a fine adjustment on the detector offset bias voltage and chiefly will affect the reading near 20 dB. R266 is a gain control and affects the scale gain factor. It also may be necessary to adjust the input signal to keep 0 dB point correct. When the V_d meter reads correctly at 0, 10, and 20 dB, move the function switch back to the NOISE position. With enough CW input signal to make the rms meter read about mid-scale, adjust the V_d Zero Adjust control on the front panel to make the V_d meter read 0 dB.

5.4.3.4 FI, PEAK, and BFO Functions

There is no separate adjustment control on FI or PEAK. The FI function is identical to the NOISE function, except that the V_d meter reads the battery voltage. When initially setting up the rms channel, it is convenient to put the meter in the FI function, disconnecting the V_d function electronics - just in case there are some problems with an unadjusted V_d channel which might interfere with the setup on the rms channel.

The PEAK function operates from much of the same circuitry as the rms function. In this case, however, a current proportional to the square of the input voltage is not integrated but is sent to a threshold detector which causes the peak meter to deflect if the current is above the reference level. Unfortunately, the gain-bandwidth product of the operational amplifiers is not sufficient to cause the output voltage to respond as quickly or exactly as needed. This causes the peak detector to read 2-3 dB lower that it should for impulsive signals. Longer duration signals,

however, will read more accurately. The main reason for including the PEAK measurement function is that this is a function which allows us to set the AGC voltage at desired, fixed values - a considerable help in troubleshooting and set-up procedures.

The BFO function is useful in checking received noise for the possibility of a signal. Unfortunately, the BFO injects some extra signal into the IF amplifiers, ruining the accuracy of any rms meter reading taken in the BFO position. Even worse, it may inject sufficient signal to cause the detector to exceed the reference level (about 30 mV at (B) on the rms integrator card). When this happens, the rms integrator attempts to reduce the input to the reference level by turning down the gain of the IF amplifier. Since the BFO is injected after the gain-control portion of the IF amplifier, no amount of AGC voltage can reduce the BFO portion of the detected signal below the reference level. Therefore, the rms integrator turns the receiver gain down all the way, and the BFO is unusable. To correct this possibility, a 2.7 Mohm resistor, R201, has been connected to pin U of the rms integrator card. In the BFO position this resistor is connected to +12 volts, cancelling out a portion of the detector output. The value of this resistor should be adjusted so that a CW signal gives about the same reading on the BFO position as it does on NOISE or FI.

5.4.4 Remote Meter Adjustment

When a remote meter is connected to the RMS-OUTPUT receptacle, J121, its internal resistance must be adjusted to match that of the panel meter, M101, if optimum accuracy is to be obtained for the remote readings. A potentiometer, R239, is provided in the EN Meter for this remote meter resistance adjustment. This adjustment is made after the rms meter scale tracking adjustments of paragraph 5.4.3, and is performed as follows:

a. Remove the EN Meter from the case, as described in paragraph 5.2.3.

b. Set the operating controls as follows:

POWER switch	to OFF position
FUNCTION switch	To FI position
ATTENUATOR switch	To 20 dB position
TUNING control	To any position
CAL control	As called for
BAND switch	To any position

c. Connect the remote meter to the RMS-OUTPUT receptacle on the front panel.

d. Check that the pointers on both the front panel meter and the remote meter are exactly at mechanical zero: if not, correct by adjusting the screw on the front of the meter case.

e. Connect the 50 ohm output of the Signal Generator to the RF INPUT receptacle on the EN Meter and set the POWER switch to the ON position.

f. Tune the EN Meter and Signal Generator to exactly the same frequency and adjust the generator output level to 1000 microvolts.

g. Adjust the CAL control to provide a full-scale indication on the panel meter (40 dB above 1 microvolt).

h. Adjust R239 until the remote meter indication is exactly 40 dB.

5.4.5 Power Supply Adjustments

The voltage regulator output is adjusted at the factory to +12, ±0.1 volts. The regulator circuit is temperature compensated, and in normal use no change in the output voltage should occur.

The battery charging current depends primarily on the battery voltage; however, it will be slightly greater in the CHARGE position of the POWER switch, than in the ON position. The maximum charging current for a fully discharged battery is approximately 130 milliamperes with the EN Meter ON, and approximately 150 milliamperes with the EN Meter OFF. The trickle charge currents for a fully charged battery are approximately 40 to 60 milliamperes, respectively. Under these conditions, the total charging time is approximately 30 hours in CHARGE, and 44 hours with the EN Meter ON.

5.4.5.1 Voltage Regulator Adjustment. The voltage regulator output is adjusted as follows:

a. Remove the EN Meter from the case, as described in paragraph 5.2.3.

b. Connect a DC VTVM between the +12 volt terminal (#1) in the IF section and ground.

c. Set the POWER switch to the ON position.

d. Adjust potentiometer R324 (located on the power supply board, Z200) to obtain +12, ±0.1 volts on the VTVM.

5.4.5.2 Charging Regulator Adjustment. If the observed battery charging time differs appreciably from those given in paragraph 5.4.5, the charging regulator may be adjusted as follows:

a. Remove the EN Meter from the case, as described in paragraph 5.2.3.

b. Connect a DC VTVM between test point "E" (plus) on the power supply board, Z200, and ground.

c. Set the POWER switch to the CHARGE position.

d. Note the voltage indicated on the front panel V_d-BATTERY meter, and enter Table 5-6 with this figure and obtain the test point "E" voltage.

e. Observing the VTVM, adjust R318 (located on the power supply board, Z200) until the VTVM indicates the correct voltage for the battery level obtained in step "d".

NOTE

If the voltage at test point "E" is greater than indicated in Table 5-6, the charging time will be longer than specified. Similarly, if the voltage is less, the charging time will be decreased.

Table 5-6. Battery Voltage vs. Charging Voltage

Battery (Volts)	Test Point "E" (Volts)
15.0	0.0
16.0	1.0
16.2	2.0
16.4	3.5
16.6	5.5
16.8	8.0

5.5 RECOMMENDED SERVICING PROCEDURES

5.5.1 General Precautions

Observe the following general precautions while troubleshooting, or replacing components within the EN Meter:

a. Use extreme care in unsoldering solid-state components, small capacitors, or resistors.

b. Do not use a soldering iron rated at more than 37 watts; do not apply heat to the connection for more than a few seconds at a time.

c. Do not excessively bend or twist leads of transistors, diodes, or small capacitors and resistors; they break off easily.

d. Do not apply any dc potentials to input terminals.

e. Do not reverse battery connections; serious damage will result.

5.5.2 Printed Circuit Boards

Printed circuit boards consist of an insulating base (lamination) conductors (foil), feedthrough couplings, and components. The lamination is the structural part of the circuit board, and supports and positions the components. As most laminations are thin, 1/16 inch or less, they are very fragile and must be handled with care.

The first step in servicing a printed circuit board is to examine the board carefully with a strong magnifying glass. Such an examination may reveal physical damage to the lamination, foil, components, or leads.

Should examination reveal a broken foil, it is usually more practical to repair the foil than to replace the entire circuit board. If the break is large, place a short length of copper wire across the break and solder the ends to the broken foil. If the break is small, try flowing solder across the break. Do not apply excess heat, or allow solder to flow to other parts of the foil.

5.5.2.1 Removal of Wires or Components. When removing wires or components from a printed circuit board, observe the following precautions:

a. Use a soldering aid for manipulating wires.

b. Use heatsinks to protect nearby parts.

c. Heat connections only until wires loosen.

d. Remove wires quickly (but carefully).

e. Remove excess solder before it hardens.

5.5.2.2 Installation or Mounting of Components. When installing or mounting components on a printed circuit board, observe the following precautions:

a. Inspect the board to verify that it is clean and dry.

b. Install heatsinks to protect components.

c. Trim component leads to the approximate length required.

d. Place the components in the correct mounting position.

e. Insert the component leads through the mounting holes in the board (or wrap the leads around mounting terminals).

f. Solder the leads in place. Use sufficient heat to assure a good soldering joint, but be careful to avoid excessive heat.

g. Trim the leads close to the solder joint on the other side of the board.

h. Clean excess solder and resin from all connections.

i. Remove heatsinks.

5.5.3 Transistor Testing

5.5.3.1 Preferred Method. If it is suspected that a particular transistor is defective, either check the transistor in a commercial transistor checker, or replace it with one of known quality.

5.5.3.2 Ohmmeter Method. If neither a transistor checker nor replacement transistor are available, the suspected transistor may be given a simple test with an ohmmeter.

WARNING

The ohmmeter must not have a higher potential than 4.5 Vdc, or damage may occur.

In checking a transistor with an ohmmeter, the transistor is treated as two separate semiconductor diodes having a common junction. In a good transistor, the diodes will have different forward and inverse resistances, depending upon the polarity of the dc voltage applied by the ohmmeter. When the anode of the diode is made positive with respect to the cathode, the forward resistance should be low. Conversely, when the anode is made negative with respect to the cathode, the inverse resistance should be high.

The greater the ratio of the inverse resistance to the forward resistance, the better the transistor. This ratio should be at least 10:1 or greater, in high quality, low-leakage transistors. A transistor is defective, and must be replaced if the forward resistance of either diode is high, if the inverse resistance of either diode is low, or if the ratio of the inverse resistance to the forward resistance is significantly lower than 10:1.

SECTION VI

PARTS LIST

6. INTRODUCTION

This Section contains a tabulated listing of all electrical components. Reference designations are assigned to each replaceable part, indicating the type of part; i.e. resistors, capacitors, transistors, etc. To locate a particular component, proceed as follows:

a. Refer to the schematic diagram for the proper reference designator and assembly.

b. Refer to the tabulated parts list for a complete description of the desired component.

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
A101	Assembly, RF Tuner	93913-1	Singer	93913-1
A102	Assembly, Power Supply	93969-1	Singer	93969-1
C101	Capacitor, Fixed, Mica, 120 pF; ±5%, 500 VDCW	11308-121	Elmenco	DM15E121J
C102	Capacitor, Fixed, Electrolytic, 47 mfd; ±10%, 20 VDCW	11555	Sprague	150D476X9020R2
C103	Capacitor, Fixed, Film, 0.15 mfd; ±5%, 80 VDCW	12293-154	Sprague	192P154-5R8
C104 thru C110	Not used			
C111 (A/D)	Capacitor, Variable, Air: Four Section	11652		
C112	Capacitor, Fixed, Electrolytic: 1 mfd; 35 VDCW	11782	Sprague	150D105X0035A2
C113	Same as C112			
C114	Same as C112			
C115	Same as C112			
C116	Same as C112			
C117	Same as C112			
C118	Capacitor, Fixed, Mylar: 0.022 mfd; ±10%, 250 VDCW	18394-223	Amperex	C-280AE/A22K
C119	Same as C118			
C120	Same as C118			
C121	Capacitor, Variable, Air: 1.8 to 13 pF	11999	E.F. Johnson	186-6
C122	Capacitor, Fixed, Mica: 24 pF, ±5%, 500 VDCW	11308-240	Elmenco	DM15C240J
C123	Capacitor, Fixed, Mica: 620 pF, ±5%, 500 VDCW	11308-621	Elmenco	DM15F621J
C124	Same as C123			
C125	Same as C118			
C126	Capacitor, Fixed, Mica: 20 pF, ±5%, 500 VDCW	11308-200	Elmenco	DM15C200J
C127	Same as C121			
C128	Capacitor, Fixed, Ceramic: Disc type, 51 pF, N330-T.C.	12768-510	Erie	805-030-S2H0-510G
C129	Same as C121			
C130	Capacitor, Fixed, Ceramic, Disc type, 33 pF, N330-T.C.	12768-330	Erie	805-030-S2H0-330G
C131	Same as C121			
C132	Same as C126			
C133	Capacitor, Fixed, Mica, 300 pF, ±5%, 500 VDCW	11308-301	Elmenco	DM15F301J
C134	Same as C133			
C135	Same as C118			
C136	Same as C121			
C137	Same as C126			
C138	Capacitor, Fixed, Ceramic, Disc type, 47 pF, N330-T.C.	12768-470	Erie	805-030-S2H0-470G

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
C139	Same as C121			
C140	Capacitor, Fixed, Ceramic, Disc type, 56 pF, N330-T.C.	12768-560	Erie	805-030-S2H0-560G
C141	Same as C121			
C142	Same as C126			
C143	Same as C121			
C144	Same as C126			
C145	Same as C121			
C146	Same as C126			
C147	Capacitor, Fixed, Mica: 30 pF, ±5%, 500 VDCW	11308-300	Elmenco	DM15E300J
C148	Same as C121			
C149	Capacitor, Fixed, Mica: 330 pF, ±5%, 500 VDCW	11654-331	Elmenco	DM15F331F
C150	Same as C121			
C151	Same as C126			
C152	Same as C121			
C153	Same as C126			
C154	Same as C121			
C155	Same as C126			
C156	Same as C122			
C157	Same as C121			
C158	Capacitor, Fixed, Mica: 620 pF, ±1%, 500 VDCW	11654-621	Elmenco	DM15F621F
C159	Same as C121			
C160	Same as C126			
C161	Same as C121			
C162	Same as C126			
C163	Same as C121			
C164	Capacitor, Fixed, Mica: 3 pF, ±0.5 pF, 500 VDCW	12323-030	Elmenco	CD6C030M500
C165	Same as C126			
C166	Same as C122			
C167	Same as C121			
C168	Capacitor, Fixed, Mica: 1200 pF, ±1%, 500 VDCW	12618-122	Elmenco	DM19F122F
C169	Same as C121			
C170	Same as C122			
C171	Same as C121			
C172	Capacitor, Fixed, Mica: 27 pF, ±5%, 500 VDCW	11308-270	Elmenco	DM15E270J
C173	Capacitor, Fixed, Mica, 56 pF, ±5%, 500 VDCW	11308-560	Elmenco	DM15E560J
C174	Same as C121			

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
C175	Same as C172			
C176	Capacitor, Fixed, Mica, 33 pF, ±5%, 500 VDCW	11308-330	Elmenco	DM15E330J
C177	Same as C121			
C178	Capacitor, Fixed, Mica: 680 pF, ±1%, 500 VDCW	11654-681	Elmenco	DM15F681F
C179	Same as C121			
C180	Same as C122			
C181	Same as C121			
C182	Capacitor, Fixed, Mica: 10 pF, ±5%, 500 VDCW	11308-100	Elmenco	DM15C100J
C183	Same as C172			
C184	Same as C121			
C185	Same as C172			
C186	Capacitor, Fixed, Mica: 210 pF, ±1%, 500 VDCW	11654-211	Elmenco	DM15F211F
C187	Capacitor, Fixed, Mica: 2 pF, ±0.5 pF, 500 VDCW	12323-020	Elmenco	CD6C020M500
C188	Capacitor, Fixed, Mica: 2 pF, ±1%, 500 VDCW	11654-201	Electro Motive	DM15201F
C189	Same as C187			
C190	Same as C186			
C191	Capacitor, Fixed, Mica: 270 pF, ±1%, 500 VDCW	11654-271	Elmenco	DM15F271F
C192	Same as C118			
C193	Same as C118			
C194	Same as C118			
C195	Capacitor, Fixed, Mica: 230 pF, ±1%, 500 VDCW	11654-231	Elmenco	DM15E231F
C196	Same as C118			
C197	Not used			
C198	Same as C191			
C199	Capacitor, Variable, Air, 0.35 to 3.5 pF	12766	Johanson	4702
C200	Same as C191			
C201	Same as C118			
C202	Capacitor, Fixed, Mica: 330 pF, ±5%, 500 VDCW	11308-331	Elmenco	DM15F331J
C203	Capacitor, Fixed, Mica: 33 pF, ±5%, 500 VDCW	1-900003-017	Electromotive	DM-15
C204	Capacitor, Fixed, Ceramic: 1.0 mfd, 25 V		Sprague	5C023105X0250B3
C205	Capacitor, Fixed, Electrolytic: 33 mfd, ±10%, 10 VDCW	18613-330	Sprague	150D336X9010B2
C206	Same as C204			
C207	Same as C191			
C208	Capacitor, Fixed, Electrolytic: 25 mfd, 25 V	1-900103-063	Sprague	TE-1207.5
C209	Same as C112			
C210	Same as C191			

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
C211	Same as C199			
C212	Same as C191			
C213	Same as C118			
C214	Same as C112			
C215	Same as C187			
C216	Same as C112			
C217	Same as C205			
C218	Same as C191			
C219	Same as C118			
C220	Same as C118			
C221	Capacitor, Fixed, Mica: 82 pF, ±1%, 500 VDCW	11654-820	Elmenco	DM15F820F
C222	Same as C191			
C223	Same as C118			
C224	Same as C118			
C225	Same as C118			
C226	Same as C204			
C227	Capacitor, Fixed, Mica: 100 pF, ±5%, 500 VDCW	11308-101	Elmenco	DM15F101J
C228	Capacitor, Fixed, Mica: 430 pF, ±5%, 500 VDCW	11308-431	Elmenco	DM15F430J
C229	Capacitor, Fixed, Electrolytic: 100 mfd, 25 V	1-900103-087	Sprague	TE1211
C230	Same as C118			
C231	Capacitor, Fixed, Plastic: 0.1 mfd, ±10%, 250 VDCW	1-900001-113	Amperex	C280AE
C232	Same as C229			
C233	Same as C208			
C234	Capacitor, Fixed, Ceramic: 0.05 mfd, 100 VDCW	1-900077-006	Sprague	TG
C235	Same as C234			
C236	Same as C234			
C237	Capacitor, Fixed, Mica: 560 pF, ±5%,	1-900003-050	Electromotive	DM-15
C238	Capacitor, Fixed, Tantalum, 10 mfd, 25 V	1-900103-042	Sprague	TE-1204
C239	Same as C229			
C240	Not used			
C241	Not used			
C242	Not used			
C243	Same as C112			
C244	Capacitor, Fixed, Electrolytic: 50 mfd, -10 +75%, 25 V	1-900039-005	Gen. Instrument	984-1654
C245	Not used			
C246	Same as C244			

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
C247	Same as C244			
C248	Same as C147			
C249	Same as C121			
C250	Same as C168			
C251	Same as C121			
C252	Same as C147			
C253	Same as C121			
C254	Capacitor, Fixed, Mica: 33 pF, ±5%, 500 VDCW	11308-330	Elmenco	DM15E330J
C255	Not used			
C256	Same as C121			
C257	Same as C254			
C258	Capacitor, Fixed, Mica: 36 pF, ±5%, 500 VDCW	11308-360	Elmenco	DM15E360J
C259	Same as C121			
C260	Capacitor, Fixed, Mica: 2200 pF, ±1%, 100 VDCW	12618-222	Cornell Dubilier	CD7FA222F03
C261	Same as C118			
C262	Same as C118			
C263 thru C270	Not used			
C271	Capacitor, Fixed, Electrolytic: 10 mfd, 15 VDCW	11722	Sprague	150D106X9020B2
C272 thru C276	Not used			
C277	Same as C164			
C278	Not used			
C279	Not used			
C280	Not used			
C281	Capacitor, Fixed, Mica: 1000 pF, ±5%, 500 VDCW	11308-102	Elmenco	DM15F102J
C282	Same as C281			
C283	Same as C118			
C284	Not used			
C285	Capacitor, Fixed, Ceramic: Disc type, 68 pF, N750-T.C.	12767-680	Centralab	DTN-680
C286	Same as C285			
C287	Same as C285			
C288	Capacitor, Fixed, Ceramic: Disc type, 47 pF, N750-T.C.	12767-470	Centralab	DTN-470
C289 thru C301	Not used			
C302	Capacitor, Fixed, Ceramic: 0.01 mfd, 1500 VDCW	10369	Erie	811-000-Z5U0-103M
C303	Same as C302			
C304	Capacitor, Fixed, Ceramic: Feed-thru, 1000 pF, -0 +100%	11684	Allen Bradley	FB2B-102W

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
C305	Not used			
C306	Same as C302			
C307	Same as C302			
C308	Same as C304			
C309 thru C311	Not used			
C312	Capacitor, Fixed, Electrolytic: 82 mfd, 50 VDCW, Tantalum	18511	Fansteel	SP314-20
C313	Capacitor, Fixed, Electrolytic: 100 mfd, 25 VDCW, Tantalum	18512	Fansteel	SP210-20
CR101	Semiconductor device, diode, stabistor, 0.65 V	18521	Transitron Elec.	SG22
CR102	Same as CR101			
CR103	Same as CR101			
CR104	Same as CR101			
CR105	Semiconductor device, diode, germanium diode	1N498	Hytron Corp.	1N498
CR106	Semiconductor device, diode: silicon diode	1N627	Sylvania	1N627
CR107	Same as CR105			
CR108	Same as CR105			
CR109	Semiconductor device, diode: silicon diode	1N916B	Texas Instrument	1N916B
CR110	Diode, zener	1-913054-111	Motorola	1N753A
CR111	Not used			
CR112	Not used			
CR113	Not used			
CR114	Not used			
CR115	Not used			
CR116	Semiconductor device, diode: Varicap (supplied in matched pairs)	18561	TRW	V100 ±20% M2B
CR117	Same as CR116			
CR118	Same as CR116			
CR119	Same as CR116			
CR120	Semiconductor device, diode:		Hewlett-Packard	HP 5082-2800
CR121	Semiconductor device, diode:	1-913007-001	Gen. Electric	1N4148
CR122	Semiconductor device, diode	1-913001-001	Motorola	1N4001
CR123 thru CR306	Not used			
CR307	Semiconductor device, diode	18508	Pacific Semicon.	PS405
CR308	Same as CR307			
CR309	Same as CR307			
CR310	Same as CR307			
CR311	Semiconductor device, diode: zener diode	1N750A	Motorola	1N750A

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
CR312	Semiconductor device, diode: zener diode	1N751A	Motorola	1N751A
CR313	Semiconductor device, diode, zener diode	1N759A	Texas Instruments	1N759A
CR314	Same as CR312			
CR315	Semiconductor device, diode: zener diode	18509	Texas Instruments	G130
CR316	Same as CR315			
CR317	Same as CR307			
DL101	Delay Line: Listed for reference only (part of Z103 Impulse Calibrator)	11988	Singer	11988
F101 thru F300	Not used			
F301	Fuse Cartridge: 1/10 ampere; 125 V	18528	Littlefuse	3AG
F302	Same as F301			
J101	Connector, receptacle, BNC	12848	Amer. Metals	B3805-77
J102	Connector, receptacle	11762	Microdot	31-03
J103	Same as J102			
J104	Binding post	10171	H. H. Eby	6604
J105 thru J110	Not used			
J111	Connector, receptacle	11486	Microdot	31-01
J112	Same as J111			
J113	Not used			
J114	Connector, receptacle	11564	Microdot	31-50
J115 thru J117	Not used			
J118	Jack, telephone	18003		JJ-089, MIL
J119	Connector, receptacle	12019		UG-1094/U, MIL
J120	Same as J119			
J121	Jack, telephone	10123		2J-1047B, MIL
J122	Same as J119			
J123	Same as J121			
J124 thru J300	Not used			
J301	Connector, receptacle	11180		MS3102E-14S-7P, MIL
J302	Not used			
J303	Not used			
J304	Connector receptacle	18326	Viking Elec.	18/1AB5
J305	Same as J304			
J306	Same as J304			
J307	Connector, receptacle	18325	Viking Elec.	VR2/4CE6
L101	Not used			
L102	Coil, audio frequency: 6 hy inductor	11721	United Xfmr	DO-T26

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
L103	Not used			
L104	Not used			
L105	Coil, radio frequency: Listed for reference only (part of Z104)	93865-1	Singer	93865-1
L106	Coil, radio frequency, 10 mh inductor	11719-103	Essex Elec.	WEE-DUCTOR
L107	Coil, radio frequency: Listed for reference only (part of Z105)	93870-1	Singer	03870-1
L108	Coil, Radio frequency: 10 uH inductor	11719-100	Essex Elec.	WEE-DUCTOR
L109	Coil, Radio frequency: 1.5 mh inductor	11719-152	Essex Elec.	WEE-DUCTOR
L110	Coil, Radio Frequency: 470 uH inductor	11719-471	Essex Elec.	WEE-DUCTOR
L111	Not used			
L112	Not used			
L113	Coil, radio frequency: 220 uH inductor	11719-221	Essex Elec.	WEE-DUCTOR
L114	Coil, Radio frequency: 100 uH inductor	11719-101	Essex Elec.	WEE-DUCTOR
L115	Coil, Radio frequency: 56 uH inductor	11719-560	Essex Elec.	WEE-DUCTOR
L116	Not used			
L117	Coil, radio frequency: 4.7 uH inductor	11719-4R7	Essex Elec.	WEE-DUCTOR
L118	Not used			
L119	Coil, Radio frequency: 3.3 uH inductor	11719-3R3	Essex Elec.	WEE-DUCTOR
L120	Same as L115			
L121 thru L300	Not used			
L301	Same as L109			
L302	Same as L109			
M101	Meter: 0-1 mA; 1500 ohms (rms)	4-403675-001	Weston	269
M102	Meter: 0-100 uA, 2200 ohm (Peak)	3-403127	Ammon Instr.	
M103	Meter: 1 mA, 12-17 V scale and 0-20 dB scale(V_d-Battery)	3-403676-001	Modutec	K1S-DMA-001
P101	Not used			
P102	Connector, Plug Listed for reference only (part of W101)			
P103	Connector, Plug Listed for reference only (part of W102)			
P104	Connector, Plug Listed for reference only (part of W103)			
P105 thru P111	Not used			
P112	Connector, Plug Listed for reference only (part of W104)			
P113 thru P306	Not used			
P307	Connector, plug	18327	Viking Elec.	VP2/4AB6
Q101	Transistor	2N502A	Motorola	2N502A
Q102	Same as Q101			
Q103	Same as Q101			

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
Q104	Same as Q101			
Q105	Transistor	2N3905	Motorola	2N3905
Q106	Same as Q105			
Q107	Same as Q105			
Q108	Same as Q105			
Q109	Same as Q105			
Q110	Same as Q105			
Q111	Same as Q105			
Q112	Same as Q105			
Q113	Same as Q105			
Q114	Not used			
Q115	Not used			
Q116	Not used			
Q117	Not used			
Q118	Transistor, PNP	1-958082-001	Fairchild	2N4250
Q119	Transistor, NPN, Type 2 N3904	1-958000-001	Motorola	2N3904
Q120	Transistor, PNP, Type 2N3906	1-938000-002	Motorola	2N3906
Q121 thru Q134	Not used			
Q135	Transistor, Type 2N3646	2N3646		
Q136	Same as Q135			
Q137 thru Q200	Not used			
Q201	Transistor, Type 2 N2552	2N2552		
Q202	Same as Q201			
Q203	Same as Q201			
Q204	Transistor, Type 2 N1711	2N1711		
R101	Resistor, fixed, composition: 10,000 ohms, ±5%, 1/4 W	11693-103	Allen Bradley	CB-1035
R102	Resistor, fixed, composition: 1,000,000 ohms; ±5%, 1/4 W	11693-105	Allen Bradley	CB-1055
R103	Resistor, fixed, composition: 12 ohms, ±5%, 1/4 W	11693-120	Allen Bradley	CB-1205
R104	Same as R103			
R105	Same as R103			
R106	Resistor, fixed, composition: 33 ohms; ±5%, 1/4 W	11693-330	Allen Bradley	CB-3305
R107	Resistor, fixed, composition: 33,000 ohms, ±5%, 1/4 W	11693-333	Allen Bradley	CB-3335
R108	Resistor, fixed, composition: 39,000 ohms, ±5%, 1/4 W	11693-393	Allen Bradley	CB-3935
R109	Resistor, fixed, composition: 47 ohms, ±5%, 1/4 W	11693-470	Allen Bradley	CB-4705
R110	Resistor, fixed, composition: 5600 ohms, ±5%, 1/4 W	11693-562	Allen Bradley	CB-5625
R111	Same as R110			

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
R112	Resistor, fixed, composition: 18 ohms, ±5%, 1/4 W	11693-180	Allen Bradley	CB-1805
R113	Resistor, fixed, composition: 270 ohms, ±5%, 1/4 W	11693-271	Allen Bradley	CB-2715
R114	Same as R113			
R115	Same as R113			
R116	Resistor, fixed, composition: 56,000 ohms, ±5%, 1/4 W	11693-563	Allen Bradley	CB-5635
R117	Same as R113			
R118	Same as R116			
R119	Resistor, fixed, composition: 2200 ohms, ±5%, 1/4 W	11693-222	Allen Bradley	CB-2225
R120	Resistor, fixed, composition: 100,000 ohms, +5%, 1/4 W	11693-104	Allen Bradley	CB-1045
R121	Resistor, fixed, composition: 470 ohms, ±5%, 1/4 W	11693-471	Allen Bradley	CB-4715
R122	Resistor, fixed, composition, 22,000 ohms, ±5%, 1/4 W	11693-223	Allen Bradley	CB-2235
R123	Same as R121			
R124	Resistor, fixed, composition: 150 ohms, ±5%, 1/4 W	11693-151	Allen Bradley	CB-1515
R125	Resistor, fixed, composition: 1000 ohms, ±5%, 1/4 W	11693-102	Allen Bradley	CB-1025
R126	Resistor, fixed, composition: 47,000 ohms, ±5%, 1/4 W	11693-473	Allen Bradley	CB-4735
R127	Resistor, fixed, composition: 220 ohms, ±5%, 1/4 W	11693-221	Allen Bradley	CB-2215
R128	Same as R125			
R129	Same as R126			
R130	Same as R126			
R131	Same as R126			
R132	Resistor, fixed, composition: 120,000 ohms, ±5%, 1/4 W	11693-124	Allen Bradley	CB-1245
R133	Resistor, fixed, composition: 68,000 ohms, ±5%, 1/4 W	11693-683	Allen Bradley	CB-6835
R134	Resistor, fixed, composition: 15,000 ohms, ±5%, 1/4 W	11693-153	Allen Bradley	CB-1535
R135	Resistor, fixed, composition: 150,000 ohms, ±5%, 1/4 W	11693-154	Allen Bradley	CB-1545
R136	Same as R108			
R137	Same as R134			
R138	Resistor, fixed, composition: 82,000 ohms, ±5%, 1/4 W	11693-823	Allen Bradley	CB8235
R139	Not used			
R140	Same as R122			
R141	Same as R122			
R142	Same as R122			
R143	Resistor, fixed, composition: 27,000 ohms, ±5%, 1/4 W	11693-273	Allen Bradley	CB-2735
R144	Same as R112			
R145	Same as R101			
R146	Same as R101			
R147	Resistor, fixed, composition: 4700 ohms, ±5%, 1/4 W	11693-472	Allen Bradley	CB-4725

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
R148	Resistor, fixed, composition: 10 ohms, ±5%, 1/4 W	11693-100	Allen Bradley	CB-1005
R149	Same as R101			
R150	Not used			
R151	Not used			
R152	Not used			
R153	Resistor, fixed, composition: 680 ohms, ±5%, 1/4 W	11693-681	Allen Bradley	CB-6815
R154	Same as R108			
R155	Resistor, fixed, composition: 18,000 ohms, ±5%, 1/4 W	11693-183	Allen Bradley	CB-1835
R156	Resistor, fixed, composition: 330 ohms, ±5%, 1/4 W	11693-331	Allen Bradley	CB-3315
R157	Same as R108			
R158	Same as R155			
R159	Resistor, fixed, composition: Listed for reference only (value selected in test)			
R160	Resistor, fixed, composition: 1500 ohms, ±5%, 1/4 W	11693-152	Allen Bradley	CB-1525
R161	Same as R138			
R162	Resistor, fixed, composition: 470,000 ohms, ±5%, 1/4 W	11693-474	Allen Bradley	CB-4745
R163	Same as R101			
R164	Resistor, fixed, composition: 180,000 ohms, ±5%, 1/4 W	11693-184	Allen Bradley	CB-1845
R165	Resistor, fixed, composition: Listed for reference only (value selected in test)			
R166	Resistor, fixed, film: 50 ohms, ±1%, 1/2 W	10935-50R0	Penn Resistor	FCA15
R167	Same as R166			
R168	Resistor, variable, composition: two section, 1000/500 ohms	11362	Allen Bradley	B1021, A5011
R169	Resistor, fixed, film: 62 ohms, ±1%, 1/2 W	10935-62R0	Penn Resistor	FCA15
R170	Resistor, Fixed, film, 249 ohms, ±1%, 1/2 W	10935-249	Penn Resistor	FCA15
R171	Same as R169			
R172	Resistor, fixed, composition: 2700 ohms, ±5%, 1/4 W	11693-272	Allen Bradley	CB-2725
R173	Same as R108			
R174	Same as R120			
R175	Same as R172			
R176	Same as R138			
R177	Same as R125			
R178	Resistor, fixed, composition: listed for reference only (value selected in test)			
R179	Same as R138			
R180	Same as R108			
R181	Resistor, fixed, composition: 3300 ohms, ±5%, 1/4 W	11693-332	Allen Bradley	CB-3325
R182	Same as R143			

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
R183	Same as R160			
R184	Same as R101			
R185	Resistor, fixed, composition: 100 ohms, ±5%, 1/4 W	11693-101	Allen Bradley	CB-1015
R186	Same as R148			
R187	Resistor, variable, wirewound: 10,000 ohms,	18546-103	Beckman Inst.	Helipot 62P-103
R188	Same as R108			
R189	Same as R138			
R190	Resistor, fixed, composition: 8200 ohms, ±5%, 1/4 W	11693-822	Allen Bradley	CB-8225
R191	Resistor, fixed, composition: 39 ohms, ±5%, 1/4 W	11693-390	Allen Bradley	CB-3905
R192	Same as R132			
R193	Same as R101			
R194	Same as R120			
R195	Same as R138			
R196	Same as R108			
R197	Same as R181			
R198	Same as R107			
R199	Not used			
R200	Same as R120			
R201	Resistor, fixed, composition: 2.7 megohms, ±5%, 1/4 W	1-945000-244	Allen Bradley	CB-2755
R202	Resistor, fixed, composition, 470 k ohms, ±5%, 1/4 W	1-945000-226	Allen Bradley	CB-4745
R203	Not used			
R204	Resistor, fixed, composition: 15 megohms, ±5%, 1/4 W	1-945000-262	Allen Bradley	CB-1565
R205	Resistor, fixed, composition: 20 k ohms, ±5%, 1/4 W	1-945000-193	Allen Bradley	CB-2035
R206	Resistor, variable, cermet, 100 k ohms, 0.5 W	1-945037-014	Beckman	Helipot 62 Series
R207	Resistor, fixed, composition: 15 k ohms, ±5%, 1/4 W	1-945000-190	Allen Bradley	CB-1535
R208	Resistor, fixed, composition, 3 k ohms, ±5%, 1/4 W	1-945000-173	Allen Bradley	CB-3025
R209	Same as R208			
R210	Resistor, variable, cermet, 10 k ohms, 0.5 W	1-945037-010	Beckman	Helipot 62 Series
R211	Resistor, fixed, composition, 4.7 megohm, 1/4 W, 5%	1-945000-250	Allen Bradley	CB-5155
R212	Resistor, variable, cermet, 1.0 meghom, 0.5 W	1-945037-018	Beckman	62 Series
R213	Resistor, fixed, composition, 1.0 megohm, 1/2 W, 5%	1-945000-234	Allen Bradley	CB-1055
R214	Resistor, fixed, composition, 62 k ohms, 1/4 W, 5%	1-945000-205	Allen Bradley	CB-6235
R215	Same as R125			
R216	Resistor, fixed, composition, 10 k ohms, 1/4 W, 5%	1-945000-186	Allen Bradley	CB-1035
R217	Same as R216			
R218	Same as R216			
R219	Resistor, fixed, composition, 22 megohm, 1/4 W, 5%	1-945000-266	Allen Bradley	CB-2265

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
R220	Same as R108			
R221	Same as R210			
R222	Resistor, fixed, composition, 11 k ohms, 1/2 W, 5%	1-945000-187	Allen Bradley	CB-1135
R223	Same as R210			
R224	Resistor, fixed, film, 30.1 k ohms, 1/2 W, 1%	1-945019-335	Penn	
R225	Same as R224			
R226	Resistor, fixed, film, 51.1 k ohms, 1/2 W, 1%	1-945019-357	Penn	
R227	Same as R226			
R228	Resistor, variable, cermet, 1 k ohms, 0.5 W	1-945037-007	Beckman	62 Series
R229	Resistor, fixed, composition, 510 ohms, 1/4 W, 5%	1-945000-155	Allen Bradley	CB-5115
R230	Resistor, fixed, composition: 1 k ohms, ±5%, 1/4 W	1-945000-206	Allen Bradley	CB-1025
R231	Resistor, fixed, composition, 20 k ohms, ±5%, 1/4 W	1-945000-193	Allen Bradley	CB-2035
R232	Resistor, fixed, composition: 51 k ohms, ±5%, 1/4 W	1-945000-203	Allen Bradley	CB-5135
R233	Resistor, fixed, composition, 5.1 k ohms, ±5%, 1/4 W	1-945000-179	Allen Bradley	CB-5125
R234	Resistor, fixed, composition, 3.6 k ohms, ±5%, 1/4 W	1-945000-175	Allen Bradley	CB-3625
R235	Same as R230			
R236	Resistor, fixed, composition, 10 k ohms, 1/4 W, 5%	1-945000-186	Allen Bradley	CB-1035
R237	Same as R236			
R238	Same as R236			
R239	Resistor, variable, wirewound, 100 ohms	18546-101	Beckman	62-101
R240	Resistor, fixed, film: 1540 ohms, ±1%	18548-1540R	Penn	FCA10
R241	Resistor, variable, composition: 100 k ohms, ±10%, 2 W	1174-1	Allen Bradley	JAIN056 P104AA
R242	Resistor, fixed, composition, 1 megohm, 1/4 W, 5%	1-945000-234	Allen Bradley	CB-1055
R243	Same as R236			
R244	Resistor, variable, cermet, 10 k ohms, 0.5 W	1-945037-010	Beckman	62 Series
R245	Same as R236			
R246	Same as R236			
R247	Resistor, fixed, composition, 20 k ohms, 1/4 W, 5%	1-945000-193	Allen Bradley	CB-2035
R248	Resistor, fixed, composition, 15 k ohms, 1/4 W, 5%	1-945000-190	Allen Bradley	CB-1535
R249	Resistor, fixed, composition, 1 k ohms, 1/4 W, 5%	1-945000-162	Allen Bradley	CB-1025
R250	Same as R249			
R251	Resistor, fixed, composition, 2 k ohms, 1/4 W, 5%	1-945000-169	Allen Bradley	CB-2025
R252	Same as R244			
R253	Resistor, fixed, composition, 36 k ohms, 1/4 W, 5%	1-945000-199	Allen Bradley	CB-3635
R254	Resistor, fixed, composition: 220 k ohms, ±5%, 1/4 W	1-945000-218	Allen Bradley	CB-2245
R255	Resistor, fixed, composition, 820 ohms, 1.4 W, 5 %	1-945000-160	Allen Bradley	CB-8215

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
R256	Same as R255			
R257	Resistor, fixed, composition, 22 k ohms, 1/4 W, 5%	1-945000-194	Allen Bradley	CB-2235
R258	Same as R257			
R259	Same as R119			
R260	Resistor, fixed, composition: 200 k ohms, ±5%, 1/4 W	1-945000-217	Allen Bradley	CB-2045
R261	Same as R135			
R262	Same as R254			
R263	Same as R120			
R264	Same as R120			
R265	Same as R143			
R266	Resistor, variable, cermet, 1 k ohms, 0.5 W	1-945037-007	Beckman	62 Series
R267	Resistor, fixed, composition, 510 ohms, 1/4 W, 5%	1-945000-155	Allen Bradley	CB-5115
R268	Same as R138			
R269	Resistor, fixed, composition, 680 k ohms, 1/4 W, 5%	1-945000-230	Allen Bradley	CB-6845
R270	Resistor, fixed, composition, 100 k ohms, 1/4 W, 5%	1-945000-210	Allen Bradley	CB-1045
R271	Same as R190			
R272	Resistor, fixed, composition, 6.8 k ohms, 1/4 W, 5%	1-945000-182	Allen Bradley	CB-6825
R273	Same as R272			
R274	Same as R110			
R275	Same as R187			
R276	Resistor, fixed, composition: 51 ohms, ±5%, 1/4 W	1-945000-131	Allen Bradley	CB-5105
R277	Resistor, fixed, composition: 15 ohms, ±5%, 1/4 W	1-945000-118	Allen Bradley	CB-1505
R278	Same as R277			
R279	Resistor, fixed, composition: 270 k ohms, ±5%, 1/4 W	1-945000-220	Allen Bradley	CB-2745
R280	Resistor, fixed, composition: 560 k ohms, ±5%, 1/4 W	1-945000-228	Allen Bradley	CB-5645
R281	Resistor, fixed, composition: 2.7 k ohms, ±5%, 1/4 W	1-945000-172	Allen Bradley	CB-2725
R282	Resistor, fixed, composition: 1.5 megohm, ±5%, 1/4 W	1-945000-238	Allen Bradley	CB-1555
R283	Not used			
R284	Same as R279			
R285	Not used			
R286	Resistor, variable, composition: 10 k ohms		Mallory	MLC 14L 10K
R287	Resistor, fixed, film, 1500 ohms, 1%, 1/4 W	1-945019-210	Penn	
R288	Resistor, fixed, composition: 680 ohm, ±5%, 1/4 W	1-945000-158	Allen Bradley	CB-6815
R289 thru R305	Not used			
R306	Resistor, fixed, composition: 7500 ohms, ±5%, 1/4 W	11693-752	Allen Bradley	CB-7525
R307 thru R312	Not used			

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
R313	Resistor, variable, wirewound: 1000 ohms	18515	Beckman	7221-R1KL-25
R314	Resistor, fixed, wirewound: 20 ohms, ±5%, 3 W	12574-200	Sprague	242E
R315	Resistor, fixed, composition: 2200 ohms, ±5%, 1/2 W	10011-222	Allen Bradley	EB-2225
R316	Resistor, fixed, composition: 100 ohms, ±5%, 2 W	10377-101	Allen Bradley	HB-1015
R317	Resistor, fixed, composition: 27 ohms, ±5%, 1/4 W	11693-270	Allen Bradley	CB-2705
R318	Resistor, variable, wirewound, 200 ohms	18510-201	Bourns	275-1-201
R319	Resistor, fixed, composition: 620 ohms, ±5%, p/4 W	11693-621	Allen Bradley	CB-6215
R320	Resistor, fixed, film: 4750 ohms, ±1%, 1/8 W	12308-4751		RN55D4751F
R321	Not used			
R322	Same as R319			
R323	Resistor, fixed, composition: 2000 ohms, ±5%, 1/4 W	11693-202	Allen Bradley	CB-2025
R324	Resistor, variable, wirewound, 500 ohms	18510-501	Bourns	275-1-501
R325	Same as R181			
RT103	Resistor, thermal: 5 k ohms	1-945070-002	Fenwall Elec.	JA35JI
RT104	Same as RT103			
S101 (A/C)	Switch, slide: single-double conversion	1-964612-	Oak	15501-103
S102	Switch, sensitive: SPDT	18536	Microswitch	12SM4
S103	Switch, rotary: wafer sections	2-403651-001		
S104	Not used			
S105	Switch, toggle, 2P3P	1-951036-007	C&K Compon.	7203
S106 (A,B)	Same as S102			
S107	Not used			
S108	Switch, rotary: 4 pole, 3 position A-D	18324	Oak	
S109	Same as S105			
S110 thru S301	Not used			
S302	Switch, toggle: DPDT	10172	A&H	83054
T101	Transformer, radio frequency: RF Input coil, p/o Z104	93864-1	Singer	93864-1
T102	Transformer, radio frequency: RF coil, p/o Z104	93866-1	Singer	93866-1
T103	Transformer, radio frequency: RF oscillator coil, p/o Z104	93867-1	Singer	93867-1
T104	Transformer, radio frequency: RF input coil; p/o Z105	93869-1	Singer	93869-1
T105	Transformer, radio frequency: RF coil, p/o Z105	93871-1	Singer	93871-1
T106	Transformer, radio frequency: RF oscillator coil, p/o Z105	93872-1	Singer	93872-1
T107	Transformer, radio frequency: RF input coil, p/o Z106	93874-1	Singer	93874-1
T108	Transformer, radio frequency: RF coil, p/o Z106	93875-1	Singer	93875-1
T109	Transformer, radio frequency: RF mixer coil; p/o Z106	93876-1	Singer	93876-1

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
T110	Transformer, radio frequency: RF oscillator coil, p/o Z106	93877-1	Singer	93877-1
T111	Transformer, radio frequency: RF input coil, p/o Z107	93880-1	Singer	03880-1
T112	Transformer, radio frequency: RF coil, p/o Z107	93881-1	Singer	93881-1
T113	Transformer, radio frequency: RF mixer coil, p/o Z107	93882-1	Singer	93882-1
T114	Transformer, radio frequency: RF oscillator coil, p/o Z107	93883-1	Singer	93883-1
T115	Transformer, radio frequency, RF input coil, p/o Z108	93885-1	Singer	93885-1
T116	Transformer, radio frequency: RF coil, p/o Z108	93886-1	Singer	03886-1
T117	Transformer, radio frequency: RF mixer coil, p/o Z108	93887-1	Singer	03887-1
T118	Transformer, radio frequency: RF oscillator coil, p/o Z108	93888-1	Singer	93888-1
T119	Transformer, radio frequency: RF input coil, p/o Z109	93890-1	Singer	93890-1
T120	Transformer, radio frequency: RF coil, p/o Z109	93891-1	Singer	93891-1
T121	Transformer, radio frequency: RF mixer coil, p/o Z109	93892-1	Singer	93892-1
T122	Transformer, radio frequency: RF oscillator coil, p/o Z109	93893-1	Singer	93893-1
T123	Transformer, radio frequency: RF input coil, p/o Z110	93895-1	Singer	93895-1
T124	Transformer, radio frequency: RF coil, p/o Z110.	93896-1	Singer	93896-1
T125	Transformer, radio frequency: RF mixer coil, p/o Z110	93897-1	Singer	93897-1
T126	Transformer, radio frequency: RF oscillator coil, p/o Z110	93898-1	Singer	93898-1
T127	Transformer, radio frequency: RF input coil, p/o Z111	93901-1	Singer	93901-1
T128	Transformer, radio frequency: RF coil, p/o Z111	93902-1	Singer	93902-1
T129	Transformer, radio frequency: RF mixer coil, p/o Z111	93903-1	Singer	93903-1
T130	Transformer, radio frequency: RF oscillator coil, p/o Z111	93904-1	Singer	93904-1
T131	Transformer, pulse: p/o Z103	1-954018-001	Pulse Eng.	PE-2671
T132	Not used			
T133	Transformer, radio frequency: IF transformer	93949-1	Singer	93949-1
T134	Transformer, radio frequency: IF transformer	93950-1	Singer	93950-1
T135	Transformer, radio frequency: IF transformer	93951-1	Singer	93951-1
T136	Transformer, radio frequency: IF transformer	93952-1	Singer	93952-1
T137	Transformer, radio frequency: IF transformer	93953-1	Singer	93953-1
T138	Transformer, radio frequency: IF transformer	93954-1	Singer	93954-1
T139	Transformer, radio frequency: IF transformer	93955-1	Singer	93955-1
T140	Transformer, radio frequency: IF transformer	93956-1	Singer	93956-1
T141	Transformer, radio frequency: IF transformer	93957-1	Singer	93957-1
T142	Transformer, radio frequency: IF transformer	93958-1	Singer	93958-1

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
T143	Transformer, radio frequency: IF transformer	93959-1	Singer	93959-1
T144	Transformer, radio frequency: IF transformer	93960-1	Singer	93960-1
T145	Transformer, radio frequency: bias oscillator transformer	93961-1	Singer	93961-1
T146	Transformer, radio frequency: BFO transformer p/o Z112	93931-1	Singer	93931-1
T147	Transformer, radio frequency: IF transformer	93263-1	Singer	93263-1
T148 thru T301	Not used			
T302	Transformer, power: primary 115/220 V	18513	Aztec	2605
U1	Diode Array		RCA	CA-3039
U2	Operational amplifier, I.C.	1-926072-001	Analog Devices	AD741KN
U3	Same as U2			
U4	Same as U2			
U5	Operational amplifier, I.C.	1-926072-002	Analog Devices	AD741CN
U6	Same as U5			
U7	Same as U2			
U8	Same as U2			
U9	Same as U1			
U10	Same as U2			
U11	Same as U2			
U12	Same as U2			
U13	Power Audio amplifier, I.C.	1-926074-001	Motorola	MFC6070
W101	Cable assembly: consists of coaxial cable with P101 on one end and replaceable connector J101 on other end	93972-1	Singer	93972-1
W102	Cable assembly: consists of coaxial cable with non-replaceable connector on one end, other end not terminated	18527-7	Singer	18527-1
W103	Same as W102			
W104	Cable assembly: consists of coaxial cable with non-replaceable connector on one end, other end not terminated	18527-10	Singer	18527-10
W105	Cable assembly: consists of coaxial cable with non-replaceable connector on one end, other end not terminated	18527-11	Singer	18527-11
Y101	Crystal unit, quartz: 2055 kHz, 6/U holder, series resonant, solder type leads	12765		
Z103	Assembly, impulse calibrator	94451-1	Singer	94451-1
Z112	Assembly, best frequency oscillator	93930-1	Singer	93930-1
Z113	Assembly, IF converter	93940-1	Singer	93940-1
Z116	Assembly, main IF amplifier	93936-1	Singer	93936-1

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
Z117-1A	Assembly, rms integrator card	1-004854-001	Singer	1-004854-001
Z121-2A	Assembly, V_d and audio amplifier card	1-004855-001	Singer	1-004855-001
Z123	Assembly, battery pack	93861-1	Singer	93861-1
Z200	Assembly, power supply regulator	93863-1	Singer	93863-1

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
C401	Capacitor, fixed, ceramic: 10 pF, 600 VDCW, NPO tubular	11658-10R	Centralab	TCZ-10R
C402	Capacitor, fixed, plastic: 0.039 mfd, ±2%, 100 VDCW, mylar foil	11466-393	Electron Prod.	E-100
C403	Capacitor, fixed, plastic: 0.02 mfd, ±2%, 100 VDCW, mylar foil	11466-203	Electron Prod.	E-100
C404	Capacitor, fixed, plastic: 0.01 mfd, ±2%, 100 VDCW, mylar foil	11466-103	Electron Prod.	E-100
C405	Capacitor, fixed, plastic: 0.00532 mfd, ±2%, 100 VDCW, mylar foil	11466-5321	Electron Prod.	E-100
C406	Capacitor, fixed, plastic: 0.00279 mfd, ±2%, 100 VDCW, mylar foil	11466-2791	Electron Prod.	E-100
C407	Capacitor, fixed, mica: 1430 pF, ±2%, 500 VDCW	11643-1431	Elmenco	DM191430G
C408	Capacitor, fixed, mica: 740 pF, ±1%, 300 VDCW	11654-741	Elmenco	DM15741F
C409	Capacitor, fixed, mica: 150 pF, ±2%, 500 VDCW	11655-151	Elmenco	DM15150G
CP401	Adapter, coaxial connector: type UG-201A/U, J407 at one end, P406 at other end	11663		
E401	Meter, Remote. consists of M401 and P408	90078-14	Singer	90078-14
E402	Antenna, rod: 41 inches long when fully extended, P401 on one end	92197-3	Singer	92197-3
E403	Ground plane, antenna coupler: consists of 12 inch square of aluminum	92199-3	Singer	92199-3
E404	Antenna, loop: consists of insulated loop and connector	90799-3	Singer	90799-3
E405	Coupler adapter, antenna: connects to J405 of E407	92192-3	Singer	92192-3
E406	Probe, RF current: consists of a secondary winding and J414, enclosed in an electrostatic shield	91550-1	Singer	91550-1
E407	Coupler, antenna: consists of eight matching transformers, matches high impedance input to 50-ohm output	92198-3	Singer	92198-3
E408	Coupler, loop antenna: consists of eight matching transformers; matches E404 loop to 50-ohm output	92200-3	Singer	92200-3
HT401	Headset, radio: magnetic type, 600 ohms impedance	10796	Telephonics	TC-149E
J401	Connector, electrical plug: 5 round male contacts	11177	Cannon	CA3106F14S5P
J402	Connector, electrical plug: 3 round female contacts	11136		MS3106E14S7S
J403	Connector, binding post: screw type (see P405) modified from Grayhill type 29-3 red	51541	Grayhill	29-3 red
J404	Connector, binding post: screw type	11665-1	Grayhill	29-3 black
J405	Connector, electrical receptacle: BNC type receptacle	11662	Auto. Metal	60-T3000
J406	Connector, electrical receptacle: type "N" coaxial connector (listed for reference only)			
J407	Connector, electrical receptacle: one end of CP401 (listed for reference only)			
J408	Plug, telephone: 3 conductors	10088	Remler	PJ068B

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
J409	Jack, telephone: for 2 conductor plug	10087	P. R. Mallory	100A
J410	Connector, electrical receptacle: Type UG-89/U (listed for reference only)			
J411	Connector, electrical receptacle: type UG-625/U	10723	Kings Elec.	UG-625/U
J412	Same as J411			
M401	Same as M101			
P400	Connector, electrical plug: 5 round female contacts	11176	Cannon	CA3106F14S5S
P401	Connector, electrical plug: type UG-260B/U	11156	Aviel Elec.	02-602
P402	Same as P401			
P403	Connector, electrical power: 3 pin connector (listed for reference only, p/o W401)			
P404	Connector, electrical plug: coaxial connector	11671	Auto. Metal	300-T1000
P405	Connector, electrical plug: pin type mates with center conductor of J403 (listed for reference only, p/o J403)			
P406	Connector, electrical plug: one end of connector adapter (listed for reference only)			
P407	Not used			
P408	Connector, electrical receptacle: 3-pin	10042	Cannon	MS3102A10SL3P
P409 thru P413	Not used			
P414	Connector, electrical plug: type UG-260/U	10228	Aviel	02-600
P415	Plug, telephone: 2 conductors	10089	Remler	PJ-055B
P416	Connector, electrical plug: one male contact	11681	Electro-Physics	P-95-2300
P417	Connector, electrical plug: 3 round female contacts	10069		MS3106B10SL3S
S401-1	Switch, rotary: (listed for reference only, p/o E407)			
S401-2	Same as S401-1			
S402-1	Switch, rotary: (listed for reference only, p/o E408)			
S402-2	Same as S402-1			
S402-3	Same as S402-1			
T401	Transformer, radio frequency: impedance matching; Band 1	92201-1	Singer	92201-1
T402	Transformer, radio frequency: impedance matching; Band 2	92202-1	Singer	92202-1
T403	Transformer, radio frequency: impedance matching; Band 3	92203-1	Singer	92203-1
T404	Transformer, radio frequency: impedance matching; Band 4	92204-1	Singer	92204-1
T405	Transformer, radio frequency: impedance matching; Band 5	92205-1	Singer	92205-1
T406	Transformer, radio frequency: impedance matching; Band 6	92206-1	Singer	92206-1

SYMBOL NUMBER	DESCRIPTION	SINGER PART NUMBER	MANUFACTURER NAME	MANUFACTURER PART NUMBER
T407	Transformer, radio frequency: impedance matching; Band 7	92207-1	Singer	92207-1
T408	Transformer, radio frequency: impedance matching; Band 8	92208-1	Singer	92208-1
T409	Not used			
T410	Not used			
T411	Transformer, radio frequency: impedance matching; Band 1	92211-1	Singer	92211-1
T412	Transformer, radio frequency: impedance matching; Band 2	92212-1	Singer	92212-1
T413	Transformer, radio frequency: impedance matching; Band 3	92213-1	Singer	92213-1
T414	Transformer, radio frequency: impedance matching; Band 4	92214-1	Singer	92214-1
T415	Transformer, radio frequency: impedance matching; Band 5	92215-1	Singer	92215-1
T416	Transformer, radio frequency: impedance matching; Band 6	92216-1	Singer	92216-1
T417	Transformer, radio frequency: impedance matching; Band 7	92217-1	Singer	92217-1
T418	Transformer, radio frequency: impedance matching; Band 8	92218-1	Singer	92218-1
W401	Cable assembly, power: 6 ft 6 in, 3 conductors (includes J402 and P403)	91258-1	Singer	91258-1
W402	Cable assembly, radio frequency: RG-55A/U cable, 20 ft (includes terminations P401 and P402)	92191-1	Singer	92191-1
W403	Cable assembly, special purpose elect: 3 ft long with P414 on one end	90071-1	Singer	90071-1
W404	Cable assembly, special purpose elect; RG-108/U cable, 20 ft (incl. term. J409 & P415)	90074-1	Singer	90074-1
W405	Cable assembly, special purpose elect: RG-108/U cable, 6 ft 6 in (terminated one end with 2 alligator clips, and P418 on other end)	90075-4	Singer	90075-4
W406	Cable assembly, special purpose elect: RG-108/U cable, 20 ft (includes terminations J408 and P417)	90075-2	Singer	90075-2

Section VII

DATA

Remote Meter 90078-14, Serial No. X NM-26T, Serial No. 622

1. STANDARDIZING GAIN

   a. FUNCTION switch to CAL position.

   b. Adjust CAL control so that the rms meter indicates the calibration figure listed below for the frequency band in operation.

Band No.	Calibration Figure, dB
1	9.75
2	9.75
3	9.75
4	9.75
5	10.00
6	10.00
7	10.25
8	9.00

2. BANDWIDTH

   Random Noise.................................. 3.19 kHz

   6 dB.. 4.56 kHz

   Impulse....................................... 5.02 kHz

CALIBRATING ENGINEER J. Vadasz

DATE 3-17-77

ADDENDUM
FOR
MANUAL NO. 1-500783-273
MODEL NM-26T

ERRATA

Correct the following errors to the above manual:

Page iii: Paragraph 1.4, Add: 1.4.3 Environmental Specifications 1-10

Page vii: CONTENTS (Continued)
TABLES, Add: 1-3 Narrowband (CW) Sensitivity 1-5
1-4 Broadband (Impulse) Sensitivity 1-5

Page 1-2: Paragraph 1.2.2 Accessory Items Available
Item 7, Was: 92200-3 Loop Antenna, Remote
Is: 92200-3 Loop Antenna, Small (15 in.)

Item 9, Was: 91550-1 RF Current Probe
Is: 91550-1B RF Current Probe (BNC Connector)

Page 1-3: Table 1-2. Accessory Items (Continued)
Below Item 26, Add: 27 95100-1 Loop Antenna, Large (46 in.)

Page 1-7: Paragraph 1.4.1.6 Sensitivity
Delete: All information and replace with Table 1-3 and 1-4, as follows:

Sensitivity. The sensitivity data in the following tables is based upon a signal plus noise to noise ratio of 3 dB (S + N/N = 3 dB). These tables are related to frequency and the specified pickup devices.

Table 1-3. Narrowband (CW) Sensitivity - FI or Noise Detection Function

Freq. (MHz)	Conducted (50Ω input)			Radiated "E" Field		Radiated "H" Field	
	μV	dBμV	dBm	41" Rod/Coupler 92197-3/92198-3	9 Ft Rod 93049-1	15" Loop 92200-3	46" Loop 95100-1
0.15 to 32	less than 0.1	less than -20	less than -127	15 μV/m 1 μV/m	2.5 μV/m 0.2 μV/m	100 μV/m 5 μV/m	32 μV/m 3 μV/m

Revision	Approved Initials	Date	Initials
E			DSR
D			DSR
C			DSR
B			DSR
A	DSR	6-25-74	DSR

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Table 1-4. Broadband (Impulse) Sensitivity - Peak Detector Function

Freq. (MHz)	Conducted (50Ω input)		Radiated "E" Field		Radiated "H" Field	
	μV/kHz	dBμV/MHz	41" Rod/Coupler 92197-3/92198-3	9 Ft Rod 93049-1	15" Loop 92200-3	46" Loop 95100-1
0.15 to 32	less than 0.1	less than 40	15μV/m/kHz 1μV/m/kHz	2.5μV/m/kHz 0.2μV/m/kHz	100μV/m/kHz 5μV/m/kHz	32μV/m/kHz 3μV/m/kHz

Page 1-8: Paragraph 1.4.1.15

a. Noise: Was: rms voltage measurement, all types of signal modulation envelopes. The V_d indicator (see (d) below) is active.
Is: True rms voltage measurement, for all types of signal modulation envelopes. The V_d indicator (see (d) below) is active simultaneously. The detector has a selectable integrating time constant of 0.1 second to 100 seconds.

b. F.I.: Was: Same as the NOISE function except the V_d indicator (see (d) below) is disabled.
Is: Same as the NOISE function except the V_d meter indicates internal battery voltage.

c. PEAK:, last sentence, Was: The V_d indicator (see (d) below) is active.
Is: The V_d indicator (see (d) below) is simultaneously active.

d. V_d, Was: ratio between rms and average voltage in NOISE position and ratio between average and peak voltage in PEAK position of function switch.

Is: Indicates ratio between rms and average envelope voltage when FUNCTION switch is in the NOISE position. Indicates ratio between average and peak envelope voltage when FUNCTION switch is in PEAK position.

Add: Paragraph 1.4.1.21. BFO. The BFO position of the FUNCTION switch provides a beat frequency for CW reception and may be used as a tuning aid.

Page 1-10: (Blank).

Add: 1.4.3 Environmental Specifications

The operational temperature range of the Model NM-26T is from

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-15°C to +50°C at 95% relative humidity. The non-operational temperature range is from -62°C to +75°C.

The Model NM-26T meets Grade A, Class 1, Type A shock requirements of MIL-S-901.

The Model NM-26T is operational to an altitude of at least 10,000 feet.

Page 4-25/4-26: Figure 4-3. NM-26T EN Meter, Schematic Diagram (Sheet 1 of 2)
Z200, PS Regulator, Delete: The meter, M103, connected to pins R and M.
Z200-R, , Was: To "K" on Z121 Is: To J306-E.

At the junction of Z200-S and S108D-common, Add: An arrow and the designation "TO CR122".

Add: Z200-J, a connector pin and socket, with the socket connected to S108D-1 and R321, a 120 k resistor - connected between the pin and the junction of R320 and pin M.

Page 4-27/4-28: Figure 4-3. NM-26T EN Meter, Schematic Diagram.
Change CR109, located between CR108 and C227, to CR106.

At the junction of J306-T and R245, Add: C241, a 1 μF capacitor, with the curved side to ground.

On the SWITCHED +12 V line, between U7 and U8, Add: C240, a 1 μF capacitor, with the curved side to ground.

CR122, Was: From pin 5 card Z200 Is: From pin S card Z200

R233, Was: 1 K Is: 5.1 k

Page 5-8: Steg g, Was: "... counterclockwise." Is: "... clockwise."

Page 5-15: Step, 2, Delete: The last sentence.

Page 5-16: Paragraph 5.4.3.2, Line2, Was: "Adjust R220...", Is: "Adjust R221..."

Page 5-17, Paragraph 5.4.3.3, Step 3, line 1:
After "PEAK position", Add: (RMS meter from mid-scale to full-scale)

Paragraph 5.4.3.4, last line,
between "for" and "impulsive", Add: short duration, low pps

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ERRATA (CONTINUED)

Page 6-5: Parts List
C240, C241, Was: Not Used
Is: Capacitor, fixed, ceramic, 1-900127-001 Sprague 5CO23105X0250B3
1 μF, ±20%, 25Vdc

Page 6-7, Parts List
CR120, Add: Singer Part Number 1-913054-111

Page 6-14: Parts List
R230, Singer Part Number, Was: 1-945000-206 Is: 1-945000-162

Page 6-15: Parts List
R286, Was: Resistor, variable, composition, 10 k ohms
______________ Mallory MCL 14L 10K

Is: Resistor, variable, composition, 10 k ohms
1-103863-001 Singer

Page 6-16, Parts List
R321, Was: Not used
Is: Resistor, fixed, composition, 1-945000-212, Allen-Bradley CB1245
120 k ohms, ±5%, 1/4 W

Pages 6-20 thru 6-22: Parts List
Add: Table Heading-Parts List for Supplied Accessories,
See Figure 4-2.

Page 4-27/4-28: Figure 4-3. NM-26T EN Meter, Schematic Diagram (Sheet 2 of 2)
Change CR109, 1N753A (connecting AGC REF No. 4 to No. 3) to CR111

Page 6-7: Parts List
CR111, Was: Not used
Is: Same as CR110

Page 6-18: Parts List

Add:	Z104	Assembly, RF Coil, Band 1	Singer No. 93770-1
	Z105	Assembly, RF Coil, Band 2	Singer No. 93873-1
	Z106	Assembly, RF Coil, Band 3	Singer No. 93879-1
	Z107	Assembly, RF Coil, Band 4	Singer No. 93884-1
	Z108	Assembly, RF Coil, Band 5	Singer No. 93889-1
	Z109	Assembly, RF Coil, Band 6	Singer No. 93894-1
	Z110	Assembly, RF Coil, Band 7	Singer No. 93899-1
	Z111	Assembly, RF Coil, Band 8	Singer No. 93905-1

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ERRATA (Continued)

Page vii: CONTENTS (Continued)
Between Section VII and Table 1-1, Add: APPENDIX
A Supplementary Battery Information A-1

Page 1-9: Paragraph 1.4.1.19 Power Source
Add: NOTE
Refer to Appendix A for supplementary battery information

Page 2-3: Paragraph 2.3.3. Battery
Add: NOTE
Refer to Appendix A for supplementary battery information

Page 3-21: Paragraph 3.7.4 Charging the Internal Battery
Add NOTE
Refer to Appendix A for supplementary battery information

Page 4-20: Paragraph 4.3.9 Power Supply
End of 1st paragraph, Add: NOTE
Refer to Appendix A for supplementary battery information

Page 5-20: Paragraph 5.4.5 Power Supply Adjustments
Add: NOTE
Refer to Appendix A for supplementary battery information

Following Page 7-1, Add: The attached Appendix A

Page 6-7: Parts List
CR109, SINGER PART NUMBER, Was: 1N916B Is: 1-913089-001

Page 6-11: Parts List

R120, Was:	Resistor, fixed, composition, 100,000 ohms, ±5%, 1/4W	11693-104	Allen Bradley	CB-1045
Is:	Resistor, fixed, composition, 68,000 ohms, ±5%, 1/4W	1-945000-209	Allen Bradley	CB6835

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FORM NO. 162 1M 3-70 D-H

APPENDIX A
Battery Supplementary Information

A. 1 The Nickel-Cadmium (NiCd) Battery

The NiCd battery has the following qualities:

a. May be recharged hundreds of times.

b. Nearly constant discharge potential during its normal operating cycle.

c. Excellent charge retention.

d. Good low temperature characteristics.

e. Rugged, sealed construction; can take much abuse.

f. May stand for long periods of time in either charged or discharged state without any adverse effects.

A. 2 NiCd Battery Discharge Characteristics

The discharge voltage is quite flat and should remain within the range of 1.20 volts to 1.25 volts per cell for approximately 80% of its normal operating range (1.25 volts to 1.10 volts). Cells should not be discharged under load to extremely low voltage. Recharging should be started when cell voltage reaches 1.10 volts under load. The low end of the battery meter scale operating range is based on the 1.1 volt point. The cell voltage under normal load drops very rapidly with time when below the 1.1 volt output level.

A. 3 Normal Battery Cycle Life

The life of the cell or battery is based on the drain and nature of its discharge cycles. If the battery is only partially discharged (1/2 to 3/4 of its capacity) on each cycle, then the number of cycles possible before the battery's usefulness is ended is extended.

Where discharges completely exhaust a cell, the cycle life can be considerably less. Where the recommended cut-off of 1.1 volts is observed hundreds of cycles should be obtained. Also, when cells are operated according to recommended procedure, termination of cell life will not be sudden. Rather, a gradual decline in capacity will result, allowing replacement on an orderly schedule.

A.4 Battery Life

The battery is capable of operating the equipment for 40 hours from a fully charged condition to the point at which the battery meter indicates below the low end of the operating range. It has been found that if the battery has been operated throughout a large number of charge/discharge cycles (all within the 50% to 100% of full-charge range) the battery capacity apparently decreases by 10% or 15%. However, this loss is normally regained after 3 or 4 sequential cycles from full-charge to the lower operating range point on the battery meter scale.

A.5 Temperature Characteristics

NiCd batteries are not recommended for use beyond the range of -15°C to +50°C (+5°F to +122°F). The following tabulation indicates the effect of temperature on the service life of NiCd batteries discharged at a "10 Hour Rate."

Discharge Temperature	Approximate Percent of +21.1°C (+70°F) Capacity
+45.0°C (+113°F)	93
+21.1°C (+ 70°F)	100
+ 4.4°C (+ 40°F)	93
- 2.2°C (+ 28°F)	88
-20.0°C (- 4°F)	60

A.6 Retention of Charge

When a fully charged battery is allowed to stand idle it will gradually lose its charge. This loss is hastened considerably by high temperatures. The following table illustrates this.

Storage Period	+55°C (+131°F) and 100% R. H.	+51.8°C (+125°F) Dry	+45°C (+113°F) Dry	+21.1°C (+70°F)	+4.4°C (+40°F)
Initial	100%	100%	100%	100%	100%
1 mo.	20%	30%	60%	88%	95%
2 mo.	5%	25%	32%	82%	90%
3 mo.	0	0	18%	80%	89%
6 mo.	0	0	0	67%	89%
12 mo.	0	0	0	41%	79%

Cells which are allowed to stand idle are not harmed by the gradual self-discharge that occurs.

A. 7 Cell Reversal

There is a phenomenon which may occur during discharge of battery packs containing series-connected NiCd cells. This is known as "cell reversal" and it may seriously affect the performance of the battery.

Reverse charging of a cell can occur during the discharge of a series string without outward indication. Individual cells do not have identical capacities. The cell in a series string that has the least capacity will dissipate all of its energy before the other cells.

Consider the case of a 25-volt battery consisting of 20 cells of 1.25 V each. The end of discharge would be 20.0 volts. We would normally assume any voltage between these two to be satisfactory. If one of the cells dissipates its energy and is down to 0 volts, it is possible that the other 19 cells will still have a total voltage of 22.8 volts, which would appear satisfactory.

However, this one cell will now be driven into reverse polarity and is being charged in a reverse direction. In the case of a 5-cell, 6.25 volt battery, the loss of one cell is immediately apparent, since the battery voltage will drop to 4.8 volts, which is below the normal 5.0 volt endpoint. Thus, it can be seen that the greater the number of cells in a series string, the more difficult it becomes to distinguish a difference in performance due to the loss of the contribution voltage of a single cell.

Reverse charging of a cell, if driven far enough, could cause permanent damage. However, a certain amount of protection against reversal is built into the cell and short reversals do not seem to have any deleterious effect. The effect of cell reversal during discharge of a series string depends upon the number of times it occurs, as well as the number of cells in series and the length of time on reverse charge. Another problem is that once the cell loses some of its capacity the effect will snowball; the cell will go into reverse charge sooner with each battery charge-discharge cycle.

Generally the cells are fairly well balanced in production batteries, and deep cell reversal is uncommon. However, for further protection, there are several equipment operational steps that can be used to minimize the possibility of cell reversal and to correct the condition if it occurs.

a. Operate the instrument on ac power whenever practical, especially when in use over extended periods of time.

b. When operating the instrument from the battery, check the condition of the battery periodically; more often when the battery is several hours into the discharge cycle.

c. Never operate the equipment on the battery when the battery voltage indicates below the operating range on the front panel meter.

d. Never forget to turn off the equipment when it is operating on the battery.

e. "Charge balancing" of the battery should be performed every month or every 15 charge/discharge cycles, whichever occurs first. Charge balancing is to deliberately charge the battery 50% longer than the normally-recommended time for fully charging the battery. Overcharging the batteries for any length of time will not damage the battery cells.

f. When cell reversal is suspected (as indicated by an abnormally low battery test voltage for a known battery charge condition), perform battery charge balancing immediately. If this does not correct the condition, then one or more cells may be permanently damaged and the battery should be replaced.

RUNNING CHANGES

Perform the following changes to the manual up to the serial number effectivity of your instrument:

Effective serial number: 241 and above

Page 4-25/4-26: Figure 4-3. NM-26T EN Meter, Schematic Diagram (Sheet 1 of 2)
Delete: R319, 620, and replace with a straight line.
Delete: CR315, G130, and CR316, G130, and connect the open side of R325, 3300, to ground.

Q201, Q202, Q203, Was: 2N2552	Is: MJE370
Q204, Was: 2N1711	Is: 2N3904
R314, Was: 20	Is: 18
R317, Was: 27	Is: 82

Page 6-8: Parts List
CR315, Was: Semiconductor device, diode, zener diode, 18509 Texas Instruments G130
Is: Not Used.

Page 6-10: Parts List
Q201, Was: Transistor, type 2N2552 2N2552
Is: Transistor, silicon, PNP 1-958001-001 Motorola MJE370
Q204, Was: Transistor, type 2N1711 2N1711
Is: Transistor, silicon, NPN 1-958000-101 Motorola 2N3904

Page 6-16: Parts List
R314, Was: Resistor, fixed, wirewound: 12574-200 Sprague 242E
20 ohms, ±5%, 3 W
Is: Resistor, fixed, wirewound, 1-945077- Sprague 242E1805
18 ohm, ±5%, 3W

R317, Was: Resistor, fixed, composition: 11623-270 Allen-Bradley CB2705
27 ohms, ±5%, 1/4 W
Is: Resistor, fixed, composition, 1-945000-136 Allen-Bradley CB8205
82 ohm, ±5%, 1/4 W

R319, Was: Resistor, fixed, composition: 11693-621 Allen-Bradley CB6215
620 ohms, ±5%, 1/4 W
Is: Not Used.

Effective serial number: 491 and above
Page 4-25/4-26: Figure 4-3. NM-26T EN Meter, Schematic Diagram (Sheet 1 of 2)
CR307 thru CR310, CR317, Was: PS405 Is: 1N4001
Add: R319, 1 M, between Q203 base and Q203 emitter.
R323, Was: 2000 Is: 1800

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TITLE ADDENDUM MODEL NM-26T

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SHEET 2, 1

Page 6-7: Parts List
CR307, Was: Semiconductor device, diode 18508 Pacific Semicon. PS405
Is: Diode, silicon, Vr=50V, If=1A 1-913001-001 Motorola 1N4001

Page 6-16: Parts List
R319, Was: Not used
Is: Resistor, fixed, composition, 1-945000-234 Allen-Bradley CB1055
1 M ohm, ±5%, 1/4 W

R323, Was: Resistor, fixed, composition: 11693-202 Allen-Bradley CB2025
2000 ohms, ±5%, 1/4 W
Is: Resistor, fixed, composition, 1-945000-168 Allen-Bradley CB1825
1800 ohm, ±5%, 1/4 W

Effective serial number: Serial numbers suffixed with 04077 and above
Page 4-27/4-28: Figure 4-3. NM-26T EN Meter, Schematic Diagram(Sheet 2 of 2)
CR105, 107 and 108, Was: 1N498 Is: 1N277

Page 6-7: Parts List
CR105, Was: Semiconductor device, diode, germanium diode 1N498 Hytron Corp. 1N498
Is: Semiconductor device, diode, germanium 1-913058-022 Sylvania 1N277

Effective serial number: Serial numbers prefixed with 601 and above
Page 4-25/4-26: Figure 4-3. NM-26T EN Meter, Schematic Diagram (Sheet 1 of 2)
R320, Was: 4750 Is: 4870

Page 6-16: Parts List

R320, Was:	Resistor, fixed, film: 4750 ohms, ±1%, 1/8W	12308-4751		RN55D4751F
Is:	Resistor, fixed film: 4870 ohms, ±1%, 1/8W	1-945027-259	Corning	RN55D4871F

Effective serial number: Serial numbers suffixed with 05304 and above
Page 4-27/4-28: Figure 4-3. NM-26T EN Meter, Schematic Diagram (Sheet 2 of 2)
R253, Was: 36K Is: 51K
Page 6-14: Parts List

R253, Was:	Resistor, fixed, composition, 36 k ohms, 1/4W 5%	1-945000-199	Allen-Bradley	CB3635
Is:	Resistor, fixed composition, 51 k ohms, 1/4W 5%	1-945000-203	Allen-Bradley	CB5135

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